Mekelle University

Department of Management

College of Business and Economics

Irrigation Management Practices In Tigray

(The Case of Qorir Small-Scale Irrigation Scheme, Klite-Awlalo Woreda, Eastern Zone of Tigray)

By

Habtamu Worku

A Thesis

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DECLARATION

I, **HABTAMU WORKU,** do hereby declare that the thesis entitled **"Irrigation Management Practices In Tigray (The Case of Qorir Small-Scale Irrigation Scheme, Klite-Awlalo Woreda, Eastern Zone of Tigray) "**, submitted by me in partial fulfillment of the requirements for the award of Master of Arts in Development Studies (Business and Development) of Mekelle University, Tigray, is original work and it has not been presented for the award of any other degree, diploma, fellowship or other similar titles, of any other University or Institution.

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Place: Mekelle, Tigray, Ethiopia

CERTIFICATION

I certify that this thesis entitled **"Irrigation Management Practices In Tigray (The Case of Qorir Small-Scale Irrigation Scheme, Klite-Awlalo Woreda, Eastern Zone of Tigray)"** is an authentic work of Mr. **HABTAMU WORKU**, Id.No CBE/PR103/02 who carried out the research under my guidance. Certified further, that to the best of my knowledge the work reported here in does not form part of any project report or thesis on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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DEDICATION

I dedicated this to my mother, ***Alemlanchy Bizuayehu***; she brought me up with the heart of a mother and always instilling in the great value of education. No words could express my gratitude and love to you.

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Abstract

The issue of food security is a serious concern especially in arid and semi-arid regions like Tigray, which is vulnerable to climatic instability and frequent droughts. To see the positive effect of irrigation on livelihood, the management aspect of irrigation must be taken in to account. Nevertheless, the management aspect of irrigation is often neglected while priorities are given to the construction of irrigation. Therefore, the purpose of this study has been to assess irrigation management practices with special reference to Qorir Small Scale Irrigation Scheme, Klite-Awlalo Woreda, Eastern Zone of Tigray, Ethiopia. The study has been focused on examining how users were organized for self-management of the scheme and how water management, conflict management, operation and system maintenance issues were practiced and challenges that hinder the sustainability of the scheme also included in the study. In order to undertake this study, household questionnaire, focus group discussion, interview and key informant interview were carried out to collect primary data from all beneficiaries of the scheme. Both quantitative and descriptive analysis techniques were used for analyzing the data. In addition, relevant literatures and essential documents were reviewed that was useful for the study. The findings of this study showed that the water committee is responsible for water allocation and distribution, coordinating maintenance activities and conflict management in the irrigation scheme with support from development agents and extension workers. Nonetheless, the water committee in the irrigation scheme is found to be inefficient in managing water distribution in terms of adequacy, timeliness and equity in the supply of water. The study result also revealed that conflict within and between groups was persistent due to water scarcity, water theft, lack of proper control of water distribution and competition (increasing number of users). Although the dam was meant to irrigate hundred hectares of the vast command area along the downstream, it irrigates about 50 hectares on average and that is small as compared to the expected potential of the irrigation scheme. This is because a significant number of beneficiaries (61.7%) faced a problem of water shortage for their agricultural activities.

Key Words: Small Scale Irrigation, Water management, Conflict management, Operation and System maintenance, Water committee

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List of Acronyms/Abbreviations

ADLI Agricultural Development Led Industrialization

Co-SAERT Commission for Sustainable Agriculture and Environmental Rehabilitation in Tigray

CPR Common Pool Resource

CRS Catholic Relief Services

CSA Central Statistics Authority

DAs Development Agents

E.C Ethiopian Calendar

EPRDF Ethiopian Peoples Revolutionary Democratic Front

ETB Ethiopian Birr

FAO Food and Agriculture Organization

FDRE Federal Democratic Republic of Ethiopia

FGD Focus Group Discussion

FTC Farmers Training Center

G.C Gregorian Calendar

ha hectare

IDD Irrigation Development Department

IIMI International Irrigation Management Institute

ILRI International Livestock Research Institute

IWMI International Water Management Institute

MoA Ministry of Agriculture

MoFED Ministry of Finance and Economic Development

MoWR Ministry of Water and Resource

NGOs Non-Governmental Organizations

PASDEP A Plan for Accelerated and Sustained Development to End Poverty

SAWAF South Africa Department of Water Affairs and Forest

SSIS Small Scale Irrigation Scheme

USAID United States Agency for International Development

WARDO Woreda Agriculture and Rural Development Office

WB World Bank

WSDP Water Sector Development Program

WUA Water Users Association

WUs Water Users

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CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

Water is a common property resource and is critical for sustainable livelihoods. Water resources can play a significant role in improving food security and household income. Irrigation is the most common means of ensuring sustainable agriculture and coping with periods of inadequate rainfall and drought (Dessalegn, 1999). The problem of food security has been keenly felt especially in the Sahel countries and Ethiopia, both of which have become increasingly drought prone. The food crises of the 1960s, 1970s and 1980s have drawn attention to the issue of environmental vulnerability and the need for its mitigation. In many of the drought prone countries, the concentration of the human population is relatively high and cannot be adequately supported by rain-fed agriculture alone. Thus, where rainfall is insufficient or unreliable and rain-fed agriculture cannot fully support food production, water management schemes have been considered to be sound investments. Such investments, it is argued, will help stabilize agricultural production and promote food security (ibid, 1999).

Water is an indivisible resource, and in this sense too it is different from most other natural resources. Water users are thus interdependent, and water control and conveyance systems affect the interests of large numbers of individuals in one way or another. The interdependence of irrigation users, for example, creates an environment in which each user loses a little bit of his or her individual control over farm practices (Bromley, 1982). Some have argued that since water is a common resource and since its utilization promotes user interdependence, its management should not be left to the responsibility of individuals.

Community natural resource management is increasingly recognized as a viable alternative to privatization or state ownership of the resource. As a result, local level resource management institutions and organizations to enforce them are receiving greater attention (Rasmussen and Meinzen-Dick 1995). However, devolving rights to local communities to manage resources,

establish use rules and regulations and enforce the rules is only a necessary condition for successful community resource management. Sustainable resource management also requires that community rules and regulations be effectively observed (Swallow and Bromley 1995). Hence, identification of the factors that favor or retard the development and effectiveness of local institutions and organizations becomes important.

Effective collective action for resource management (in this case irrigation) requires that the beneficiaries prepare and agree on a set of rules of restrained access to the resource; make arrangements for financial, labour or other contributions required for the management of the resource and lay out a system of enforcement of the use restrictions and community contributions (Gebremedhin et al, 2002).

Participatory irrigation management has been considered as the driving force in the effective and efficient irrigation management by participating and involving the farmers in planning, operation and maintenance of the irrigation system (Gulati et al. 2005). Farmer- managed irrigation systems are found in varied environments and exploit a wide range of technologies to take advantage of different types of water sources for production of a diversity of crops. All these irrigation systems, however, require that certain indispensable tasks be accomplished if the system is to function productively (Edward and Robert, 1987).

To reach the millennium development goals (such as eradicating poverty in half by 2015) much more efforts must be undertaken to increase the productivity in agriculture and the value of products produced, since farming is the foundation of the rural poor. To reduce the risks linked with rainfall unpredictability and to increase the yields of food crops, more public investments in yield-enhancing technologies—such as small-scale irrigation and irrigation management practices—have been suggested as one important rural development and poverty reduction strategy (Pinstrup and Pandya, 2001).

Since irrigation is an arena of struggle where social actors negotiate and decide on the technology choice and management of the water, it is true that the management aspect of irrigation must be taken in to account. However, Ostrom (1990) complained that ‘the initial plans for many of irrigation projects in developing countries have focused almost exclusively on engineering

designs for the physical systems. Distribution of water for farmers and subsequent maintenance were frequently not addressed'.

After the construction of the irrigation infrastructure, some form of irrigation management should be in place to run the irrigation system. In many irrigation projects the issue of irrigation management should be considered at the same time as the physical works (Woldeab, 2003).

To eradicate poverty, water management institutions play a significant role in the allocation and distribution of irrigation water. Cultural bonds may equally foster mutual ties out of which such an institution can be built, and such natural social cohesion forms a strong basis upon which to form an institution (SAWAF, 2002).

The main function of irrigation water management organizations is normally to manage the annual flow of irrigation water from the main feeding canal, coordinate the sharing of irrigation water among the different farming units, and presuppose responsibility for the maintenance and repair of the on-farm infrastructure. If they are properly registered and put on a secure legal basis, irrigation water management organizations will also become an effective way for farmers to represent their interests with reference to local and national authorities on a wide range of issues relating to the allocation of water rights and the administration of irrigation infrastructure (Burger, 1998, cited in Teferi, 2010). Improved irrigation management may lead to better production and getting it to the market at the right time. And in turn, this leads to the availability of products at affordable price to the poor.

In Ethiopia, modern small scale irrigation schemes have been constructed by the federal or regional government in order to overcome the catastrophic climatic change and drought since 1973. Such schemes involved dams and diversion of streams and rivers. Subsequent to construction, usually dams are transferred to WUAs for management, function and maintenance with the support of personnel from regional bureaus (IWMI, 2005). Moreover, long established water committees, locally known as 'water father', administer the water distribution and coordinate the maintenance activities of the schemes (FAO, 2005).

1.2. Statement of the Problem

According to the Plan for Accelerated and Sustained Development to End Poverty (MoFED: PASDEP, 2006), the main development objective of the Ethiopian Government is poverty eradication and hence the country's development policies and strategies are tend towards this objective.

To reach this objective, in the last 15 years the government of Ethiopia has been making efforts to expand irrigation schemes all over the country. The country's Agricultural Development Led Industrialization (ADLI) considers irrigation as a means to increase agricultural production and food security in the country. Although the government exerts its effort to expand irrigation, the country has still not achieved sufficient irrigated agriculture to overcome the problem of food security and poverty in Ethiopia (Haile, 2008).

Woldeab (2003) argued that although both the human and physical aspects interact in the irrigation domain, the management aspect of irrigation is often ignored while priorities are given to the construction of irrigation. Gebrehaweria (2004) also supported the idea of Woldeab (2003) that irrigation development in Ethiopia has been overwhelmed by the emphasis on the agronomic, engineering and technical aspect of water projects whereas little consideration has been given to the managerial and beneficiary participation aspects of the irrigation scheme. He also added that the experience of irrigation water development in the last five decades in Ethiopia suggests that several measures need to be taken to support farmer managed small scale irrigation projects.

According to the Woreda Agriculture and Rural Development Office (WARDO, 2010), Qorir Small Scale Irrigation Scheme was meant to irrigate over an estimated 100 hectares of the vast command area along the downstream. Nevertheless, irrigated areas from the water collected in the dam have never exceeded an estimated 72 hectares of irrigated area during years of its best run off yields. This could be because of water scarcity and a number of illegal water abstractions in the irrigation scheme. However, to get the necessary impact and economies of scale, FAO (1986) argued that a substantial area usually needs to be developed and it must be cropped intensively. Therefore, to achieve a sustainable production from irrigated agriculture, it is true

that the managerial and participation of beneficiaries issue must be taken in to account otherwise the sustainability of the scheme will be endangered.

Up to the best of the researcher studies that were conducted in our country on the issue of irrigation concentrated on its impact on food security. Their study did not show the managerial aspects such as water management, conflict management, operation and maintenance and how the users are organized for self management. This is, therefore, the reason why the researcher becomes motivated to work on irrigation management practices.

1.3. Objectives of the Study

The general objective of this study is to assess irrigation management practices of Qorir Small Scale Irrigation scheme in Tigray.

Specific objectives of this study are;

- To analyze the management of small scale irrigation system such as water management, conflict management and operation and maintenance of the irrigation system
- To identify the major challenges that hinder the sustainability of the irrigation scheme
- To understand how users are organized for self-management of the irrigation and analyze the constraints they are facing
- To examine the contribution of Water User's committee in the management of the irrigation scheme

1.4. Research Questions

- How is the existing management of the irrigation system going on?
- What are the major challenges that hinder the sustainability of Qorir small scale irrigation scheme?
- How are water users organized for irrigation management? What are their key constraints?
- What are the functions of Water User' committee in the management of the irrigation scheme?

1.5. Significance of the Study

To realize ADLI, Ethiopia should not be highly depending on rainfed agriculture rather it should be supplemented by irrigation. Irrigation can be taken as a means to increase agricultural production and maintain food security. To check their impact, many studies have been made on irrigation but managerial aspect of irrigation has not been yet studied. Hence, research is needed to assess the managerial aspect of irrigation schemes that could be taken as information for further study.

In addition to this, this study will serve as a good basis for forthcoming researchers who have a strong desire to carry out a research on this or related topics in Tigray region and can contribute to the current literature on commons and how to establish and manage common resources successfully through collective action(in this case irrigation). Furthermore, the outcome of this study may serve as a source of additional information for use by policy makers and planners during the design and implementation of irrigation development programs and prospects. Finally, the finding of this study may then be emulated by other countries which have similar characteristics.

1.6. Scope and Limitation of the Study

This study was based on a cross-sectional data for the time period of 2011GC aimed at analyzing irrigation management practices of Qorir Small Scale irrigation scheme. It is true that there are different woredas where irrigation is practiced in Tigray region. Had there been abundant resources (including work force, time and finance) for this study, the researcher would have unreserved interest to conduct the study in every woredas[1]. To conduct this study, a census was used and research tools such as household questionnaire as well as interview and focus group discussion were employed. This study was confined only to the managerial aspect of the scheme. The researcher was not go through other dimensions of the irrigation.

[1] is an administrative divisions of Ethiopia(managed by local government), equivalent to district

1.7. Organization of the Paper

This thesis consists of five chapters. The first chapter, the introductory part, has sections that deal with background, problem statement, objectives of the study, research questions, significance of the study, scope and limitation of the study and organization of the paper. Chapter two provides literature and empirical review of the study and then followed by the third chapter entitled as methodology of the study. The fourth chapter devoted to results and discussions of the study. Finally, chapter five presents conclusions and recommendations of the study.

CHAPTER TWO

LITRATURE REVIEW

2.1. Irrigation and Irrigation Management

Irrigation is the artificial application of water to soil for the purpose of crop production. Irrigation water is supplied to supplement the water available from rainfall and the contribution to soil moisture from ground water (Michael 1997). Irrigation management is normally defined as "a process by which institutions or individuals set objectives for irrigation systems, establish appropriate conditions and identify, mobilize and use resources so as to attain these objectives while ensuring that all activities are performed without causing adverse effects" (IIMI, 1992).

In irrigated crop production a number of interrelated activities ranging from designing and constructing of the irrigation infrastructure to water acquision and watering crops are carried out (Wodeab, 2003). Uphoff (1986) cited in Woldeab (2003) identifies three categories of irrigation management activities and organizational activities. The first involves water acquisition, distribution, and drainage. The second focus on design, construction, operation and maintenance. The third focuses on conflict management, communication, resource mobilization and decision making. The management aspect of irrigation is often neglected while priories are giving to the construction of irrigation infrastructure, although both the human and physical aspects interact in an irrigation domain.

Byrnes (1992) conjointly classified irrigation management activities in to a few dimensions. These are water use activities, management structure activities and organizational activities.

Water use activities: are management activities that are focusing on the provision of water to crops in an adequate and timely manner include acquisition, allocation, distribution and drainage.

- Acquisition is the first management activity concerned with the acquisition of water from surface or subsurface sources, either by creating and operating physical structure such as dams' weirs or wells or by actions to obtain some share of an existing supply.

- Allocation on the other hand is heavily refers to the assignment of rights to users thereby determining who shall have access to water.
- Distribution refers to the physical process of taking the water from a source and dividing it among users at certain places, in certain amounts, and at certain times.
- Drainage is important where excess water must be removed.

Control structure activities: are management activities that are focusing on the structures required for water control include design, construction, operation and maintenance. Design involves the design of dams' diversions or well to acquire water, of systems of rules to allocate it, of channels and gates to distribute it and of drains to remove it. Construction involves the construction of the structures to acquire, distribute and remove water, or implementation of rules that allocate it. Operation refers to the operation of the structures that acquire, allocate, distribute or remove water according to some determined plan of allocation. Maintenances are the final control structure activity. This provides for the continued and efficient acquisition, allocation, distribution and drainage.

Organizational activities: are management activities focusing on the organization of efforts to manage the structures that control irrigation water includes resource mobilization conflict resolution communication and decision-making. The activity of resource mobilization entails marshalling management and utilization of funds manpower, materials, information or other inputs needed to control water through structures or to undertake various organizational tasks.

The activity of communication entails conveying information about decisions made, resource requirements etc. to farmer or any other persons involved in irrigation managements. The activity of decision making entails the processes including planning involved in making decision about the design, construction, operation or maintenance of structures; acquisition, allocation, distribution or drainage of water or the organization deals with these activities.

2.2. Irrigation Water-As a Common Pool Resource (CPR)

Common pool resources are products where, like public product, it is pricey or troublesome to exclude potential users, that are subtractable (rival in consumption), like that of personal product. Two characteristics distinguish public product from personal product 1) excludability that refers

to the flexibility of provides of a decent or service to exclude or limit potential beneficiaries from consuming and 2) rivalry that refers as to whether or not one person's use or consumption of a decent or services reduces its availability to a different. Thus, CPRs create each the issues of provision and also the risk of depletion. CPRs do not fulfill the pure public product characteristics of non-subtractability. Thus, they are vulnerable to the chance of over extraction (Bedru, 2007). As shown in the following table, private goods are characterized by both high excludability and high rivalry, while public goods are characterized by low excludability and low rivalry.

Table 2.1: Types of Goods, Rights and Owners

	Goods	**Rights**	**Owners**
Private	-Excludable -Substractable	-Specifies clearly what the rights-holder is entitled to do -Is secure so that the holder of the right is protected from confiscation by others -Is exclusively vested in the holder of the right and definitely not in no holders of the right	-Represents only itself
Public	-non-excludable -non substractable	-Rights of access and use that do not include the right to exclude others from such use	-Represents the general population and not just a single individual
CPR	-non-excludable -substractable	-Group of individuals share private property rights -Systems of shared private rights owned by private entities	-Group of individuals (shared, joint or collective) ownership -Community ownership

Source: adopted from Bedru, 2007

Water falls within the variety of rain, and flows and evaporates no matter any boundary. However, Water is subject to rivalry in consumption and as a result of this it can not be grouped under public product rather it is a common pool resource that there is a restricted quantity that has got to be shared in common over a range of uses.

However, Bromley (1992) viewed resources controlled and managed as common property, state property, personal property or resources over that no property rights are given. For him "Irrigation systems represent the essence of a standard property regime. There is a well-defined cluster whose membership is restricted, there is an asset to be managed (the physical distribution system), there is an annual steam of advantages (the water that constitutes a valuable agricultural input), and there is a requirement for cluster management of each the capital stock and also the annual flow (necessary maintenance of the system and method for allocating the water among members of the cluster of irrigators) to form certain that the system continues to yield advantages to the cluster."

Ostrom (1990) in her seminal book "Governing the Commons", too complains concerning the misleading understanding when definitions do not seem to be clearly created. Failure to differentiate between subtractability of the 'resource units' (water unfold on one farmer's field can not be unfold onto the sphere of somebody else) and also the jointness of the resource system (all appropriators advantages from maintenance of an irrigation canal) ends up in confusion concerning the link of common pool resources to public resources (or collective resources). Typical for a common pool resource is that the subtractability of the resource unit that ends up in the likelihood of approaching the boundaries of the amount of resources units made (ibid).

The Hardin's famous article "tragedy of the commons" (1968) is employed to specific the degradation of the atmosphere to be expected when several people use commonly a restricted resource. He explains the logic behind this model explaining it by the accepted example of a pasture with open access to any or all. The essence is that every herder is motivated to feature additional and additional animals and bears solely a share of the prices ensuing from overgrazing. Since users are probably to ignore the results of their actions on the pool when pursuing their self-interest, it should be concluded that the majority of the resources bear the danger of a tragedy of the commons.

A research done by Ostrom (1990) criticizes the approaches to unravel tragedy of the commons social dilemma as insufficient. It is neither sufficient to form a system of personal property rights, neither is it the sole answer that the central government stay management over common resources. Significantly, Ostrom contributes to an empirically valid theory of self organization

and self governance with the read to the matter of common pool resource (Ostrom, 1990). The implication is that collective action may be a way by that societies will hold common property resources and use the resources in a very sustainable manner. "Collective action is action by over one person directed towards the achievement of a typical goal or the satisfaction of a typical interest (that is, a goal or interest that can not be obtained by a private working on his own). If the common goal or common interest is characterized by infinite edges and non-exclusion, the achievement of that common goal or interest implies that a public or collective sensible has been provided. Thus, the collective action may be 'formulation of a rule of restrained access to a common-pool resource and observance of that rule', and also the public sensible may be the case of sustainable exploitation that results" (Wade, 1987).

2.3. Irrigation System as a Sociotechnical System

Different approaches have been employed in the analysis of irrigation by different scholars. Eggink and Ubels (1984) (cited in Woldeab, 2003) identify three approaches: the technocratic approach, the organizational approach and the social force approach. The technical infrastructure of the irrigation system is the main focus of the 'technocratic approach'. Importance is given to large scale construction and rehabilitation work. Irrigation management is confined to the operation and maintenance of the irrigation infrastructure. The 'organizational approach' mainly focuses on the management of irrigation systems. Organizational problems with respect to water distribution in large scale irrigation systems are studied. The 'social force approach' considers irrigation as ' a way of producing, a social activity, shaped by the dialectical interaction of social force and, in that process, becoming a social force in itself and influencing further development in society'(ibid,2003). Problems in irrigation systems are examined as an ongoing struggle between different interest groups over water. These approaches have attempted to examine irrigation in a non-comprehensive way using individual disciplines such as engineering, management, anthropology and economics.

Mollinga, 1998 (cited in Woldeab, 2003) criticizes past management and economics literature on irrigation and current approaches to irrigation studies for having three conceptual problems: lack of appreciation of the social dimension of technology, simplified concept of the human agency and little interest in social relations of power and the institutional forms through which purposes

of irrigation are achieved. He argues that an interdisciplinary investigation of irrigation requires insights into its technical, organizational or institutional and socio-economic and political aspects.

Mollinga, 1998(cited in Woldeab, 2003) outlines the social dimension of the irrigation system in terms of three basic concepts: social construction, social requirements for use and social effects.

2.3.1. Social Construction

He explains what is meant by the idea that 'irrigation technologies are socially constructed';

- ✓ Technology development and design are social processes in which different stakeholders interact (communicate, negotiate, take decisions) and
- ✓ The nature of that process and the different perceptions and interests of the stakeholders shape the technical characteristics of the technologies

2.3.2. Social Requirements for Use

Horts, 1998 (cited in Woldeab, 2003) defines an 'irrigation system' as 'the physical infrastructure needed to capture, transport, and distribute to farms'. To a considerable degree the source of water (river, dam or ground water) and the canal system in use determine the type of organizations needed in an irrigation system. Difference in the sources of water may require different forms of management.

In an irrigation system where dam technology is used as the water harvesting technique, the water allocation (scheduling) practice is dependant on the volume of water stored in the dam. Accurate measurement of the available water on a regular basis is important to determine the irrigable land size in the irrigation system and irrigators could also decide the type of crop to plant.

The transport of water from a dam to the farms needs an efficient canal networks to tackle problems such as water logging and soil salinity. Hence, farmers may need training in techniques of water management, irrigated agriculture, and conservation of resources.

2.3.3. Social Effects

The third way in which irrigation technologies are socially relevant is in their social effects. It is very important in irrigation that farmers get water on time with required quantity. The canal structure conveys the water to the fields. An ill-designed canal or dam limits farmer's access to water. Furthermore, unreliable water supply may have a negative effect on the management an irrigation system. If farmers consider that the arrival of water in the canal is unreliable and quite unpredictable, or if they have not had any for a long time, their participation in water management could be curtailed.

2.4. Water Users Association and Collective Action

A water users' association, or WUA, is a nongovernment, nonprofit organization initiated and managed by a group of farmers and other water users along one or more hydrological subsystems or watercourses. By organizing themselves, water users can exert their financial, material, technical, and human resources needed to manage, operate, and maintain an efficient irrigation and drainage system in their locality (USAID, 2006). According to the report of USAID on water users association in Afghanistan in 2006, the major benefits and functions of having a WUA are as follows:

- Creation and enforcement of a unified set of water use rules within the area it serves;
- A more responsive, better understood, and well-respected water management system for farmers and other water users;
- A more equitable distribution of water among farmers regardless of their location, type and size of farm, and status (whether a WUA member or not);
- A much more reliable water supply for particular crops and other needs;
- More efficient use of water that will minimize waste and prevent erosion, water logging, and over-watering of irrigated lands;
- Prevention of illegal water theft;
- Faster and more efficient resolution of disputes between and among WUA members and nonmembers over the distribution and use of water, the management of irrigation and drainage infrastructure, and the operation and maintenance of equipment;

- ❖ Better maintenance of irrigation canals, drainage and other infrastructure, operating and maintenance equipment, and other properties owned by the WUA;
- ❖ Better protection of the environment;

According to Von Benda -Beckmann and Von Bendci-Beckmam, 2000 quoted in B. Van Koppen 2002, irrigation institutions are defined as the collective arrangements at scheme level for water control and use which include water distribution, construction of infrastructure, maintenance and rehabilitation. Water is derived from streams, dam, river diversion or groundwater, then allocated and distributed.

Identifying factors that create attainable and effective of collective action for the event of irrigation will facilitate to spot where collective action will be established simply and effectively and it is necessary to spot conjointly where efforts are required for the institution and effectiveness of collective action. The thematic analysis areas concerning collective action for irrigation management embody how individuals organize themselves with respect to irrigation water, what consistent policies and different instruments will be utilized to rework stakeholder's manner, and the way common property management be used to facilitate and initiate native organizations for water management. Individuals will learn from the success of traditional irrigation systems, particularly from the institutional, managerial and legal facet of water administration and management. Understanding the evolution, development and functioning of ancient water uses associations ought to provide necessary insights on a way to organize and develop trendy irrigation associations (Gebremedhin et.al, 2003).

International expertise with farmer irrigation management suggests that, for a successful community management of irrigation schemes, the economic and money prices of sustainable self –management should be a little proportion of improved income, the transaction price of the organization should be low, and irrigation should be central to the development of livelihoods for a major range of members. Developing native leadership skills for irrigation management conjointly seems to be a key issue for successful collective irrigation management (ibid, 2003).

2.5. Irrigation Management Experiences in Ethiopia

According MoWR (2002) irrigation schemes in Ethiopia are classified into three on the basis of size of land area irrigated.

1. *Large and medium scale irrigation* – Irrigation projects in Ethiopia are identified as large-scale irrigation if the command area is greater than 3,000 hectare, medium–scale if it falls in the range of 200 to 3,000 hectare. Even though these types of irrigation schemes are considered important, the number of such projects has remained stagnant in the last decade. They are associated with useful infrastructure development, create job opportunities, and contribute to agricultural growth and the macro economy. Parallel to the water sector development program, there are a remarkable effort to develop master plans for various river basins. Actually, comprehensive master plans for five basins have already been developed.

2. *Small scale irrigation schemes* - it includes traditional small–scale schemes up to 100 hectare and modern communal schemes up to 200 hectare. There might also be especial instances, such as the traditional spate irrigation in Tigray which would cover up to 400 hectare. The construction of these kinds of schemes is initiated by farmers with limited assistance from the government. The farmers manage it through their own water users association or committees. The farm size varies from 0.25 hectare and 0.5 hectare.

To manage traditional schemes, water user associations have long existed. WUAs are well organized and operated effectively. Since there is a strong social capital in the water users associations, there is not a problem of information asymmetry. Typically, members' number can be up to 200 users who share a main canal or a branch canal. The associations handle construction, water allocation; operation and maintenance functions. Small-scale modern schemes can be also constructed by the Federal or Regional government in order to overcome the catastrophic climatic change and drought since 1973. Such schemes involved dams and the diversion of streams and rivers. Subsequent to construction, usually dams are transfer to Water Users Associations for management, function and maintenance with the support of personnel from Regional Bureaus (IWMI, 2005).

Generally, small scale systems could have larger benefits than large scale systems. Small scale technology will be primarily based on farmers' existing data and native technical, managerial and entrepreneur skills. Migration and resettlement of the labor is not sometimes needed, designing will be a lot of versatile. Additionally, social infrastructure needs are lower. Moreover, there is general agreement that the success of small-scale systems is also due to the fact that they are *self-managed* and dedicated to the felt needs of local communities. Indeed, small-scale schemes are defined as schemes that are controlled and managed by the users themselves.

Generally, according to Dessalegn (1999), small scale irrigation schemes have the following advantages:

- they have much lower investment costs, and in a majority of cases these costs are borne by the community;
- they do not involve dams or storage reservoirs, hence no population displacement is involved;
- they are less demanding in terms of management, and operation and maintenance;
- they have no land tenure or resettlement implications;
- they have no serious adverse environmental impact;
- they allow a wider diffusion of irrigation benefits; and
- they permit farmers to learn irrigation techniques at their own pace and in their own way.

On the opposite hand, large scale schemes will make sure the advantage of the encompassing population by providing employment opportunities. However, the successfulness of the irrigation system isn't determined by its size however by its institutional, physical and technical factors (IWMI, 2005)

3. Micro-irrigation – This system is not understood in the same way in the different places of the country. Sometimes the term is used for small-scale schemes of less than one hectare developed at household level, such as rainwater harvesting. Others consider micro irrigation in relation to the technology used. For example, drip irrigation needs treadle and small power pumps to lift water; and a variety of irrigation application technologies, such as small bucket and drip systems and small sprinkler systems. Micro irrigation has the following advantages: - it can be used

individually, low cost in terms of their capital and operating costs per farm. They are efficient in use of water with high productivity, with improving crop quality and reducing labor costs. Currently, the use of micro irrigation in Ethiopia is low with regard to area covered or volume of water used.

Actually, the use of micro irrigation by poor farmers has not properly begun in the country. Its introduction is a recent phenomenon and some attempts are done by the government, some NGOs and Universities (IWMI, 2005).

Table 2.2: Irrigation experience in the Ethiopia

Schemes	Areas irrigated (hectares)	Remarks
Large & medium	89	As of mid 1980s
Small scale	10	Includes micro dams & pumps
Traditional	69	Based on incomplete data
Total	168	

Source: MOA 1986, 1992, 1993 (in Desalegn, 1999)

2.6. Irrigation Development in Ethiopia

Even though irrigation in Ethiopia dates back a number of centuries, if not millennia, especially in some parts of the country like the Konso community, modern water development schemes are a relatively new phenomenon in the country (Dessalegn, 1999).The country's irrigation potential ranges from 1.0 to 3.5 million hectares of irrigable land, of which between 160 –190 thousand hectares (5-10%) is estimated to be currently irrigated (Gebremedhin and Peden, 2002).The overall irrigated area by traditional small scale irrigation scheme is estimated to be about 138,000 ha and about 572, 000 farmers are involved. Long-established water committees, locally known as 'water fathers', administer the water distribution and coordinate the maintenance activities of the schemes (FAO, 2005).

The Imperial government took the first initiative in water resource development in the second half of the 1950s. Large-scale water projects for agricultural purposes and power generation were constructed from the end of the 1950s, and were concentrated in the Awash valley as part of the

agro-industrial enterprises that were expanding in the area at the time. They subsequently spread to the Rift Valley and the Wabe Shebelli basin. Essentially, the government's interest at the time centered almost entirely on large-scale and high technology water projects: hydro-power dams, irrigation schemes, and water supply projects for Addis Ababa and a few major towns. Since then, all large-scale schemes in the country have been constructed at the initiative of the government, and managed by state or parastatal enterprises (Dessalegn, 1999). At the beginning of 1970's, about 100 thousand hectares of land was estimated to be under modern irrigation. During the imperial regime, the main objective of irrigation was to provide industrial crops to the growing agro-industries in the country, many of which were controlled by foreign interests, and to increase export earnings (Gebremedhin and Peden, 2002).

For much of the lifetime of the Derg, very little attention was paid to small-scale and traditional irrigation schemes constructed and managed by peasant farmers. With the nationalisation of industrial and agricultural enterprises, the government's emphasis was to promote high technology water development schemes managed by state-controlled agro-industrial and agricultural enterprises. It was only in the second half of the 1980s, as a result of the devastating famine of 1984/85, that the Derg began to show interest in small-scale water management schemes. The establishment of the Irrigation Development Department (IDD) within MoA at the end of 1984, a body entrusted with the development of small-scale irrigation projects for the benefit of peasant farmers, signaled a new approach to water development by the military government (Dessalegn, 1999). However, progress was slow. From the mid-1980s to the fall of the Derg in 1991, IDD was able to construct some 35 small schemes (MoA, 1993), of which nearly one-third were formerly traditional schemes used by peasants.

After 1991, when EPRDF took power, the focus on large-scale irrigation development and the neglect of small-scale schemes was reversed. The EPRDF government has given more attention to the development of small-scale irrigation schemes and improvement of farmer–managed traditional schemes at the forefront of its water development policy. The establishment of MoWR (Ministry of Water Resources) enables the unification of public agency for water resources development. Irrigation Development Department (IDD) was dissolved in 1994 and was replaced by Regional Commissions for Sustainable Agriculture and Environment Rehabilitation (Co-SAERS) in a number of regions. The primary mandate of the Co-SAERs also remained rather

technical–oriented, with inadequate attention accorded to policy, socio-economic and managerial issues (Gebremedhin and Peden, 2002).

In sum, irrigation development planning in Ethiopia has been beset by the emphasis on the agronomic, engineering and technical aspects of water projects, with little consideration to issues of management, beneficiary participation, availability of institutional support services such as credit, extension and input supply, and marketing. The experiences of irrigation water development in the last five decades in Ethiopia suggest that several measures need to be taken to support farmer-managed small-scale irrigation projects in Ethiopia (Ibid, 2002).

2.7. Status and Potential of Small Scale Irrigation Scheme in Ethiopia

Irrigation in Ethiopia is classified into three classes. They are small, medium and large-scale irrigation schemes. Small Scale supplies a total command area of under 200 ha as opposed to medium and large scale, which are 200-3000, and above 3000 ha respectively (MWR, 2001b).

The present most frequently cited estimate of small-scale irrigation estimated area is about 65,000 has (MWR, 1998; CSA, 1998; AQUASTAT, 1998; IDD/MOA, 1993 as cited in CRS, 1999)). These Figures are in sharp contrast to the widely cited overall potential for irrigation throughout the country, including small, medium and large-scale irrigation. Tab.2.3 provides an overview of the present reference data regarding the scope for small-scale irrigation in Ethiopia.

Table 2.3: The potential area for and actual status of small scale irrigation in Ethiopia

Reference Source	Potential Irrigable Area (hectares)	Actual Irrigated Area (hectares)		Notes/Observations
CSA(1998)	-	95/96 84,640	96/97 68,210	Meher (main rainy) season
AQUASTAT (1998)	165,000 - 400,000	63,581		An online data base supported by FAO. Raises issue of need for rehabilitation
MWR (1998)	180,000	64,000		Notes that some schemes are not functioning and in need of rehabilitation
Tahal (1998)	-	40,270		Traditional Schemes only- those without assistance from outside the community
IDD/MOA (1993)	352,000	70,000		Estimate of traditional irrigation without external assistance
FAO (HRDP)	270,000	-		Potential for SSI using both ground water and surface water sources

***Source*:** programmatic Environmental Assessment of small-scale irrigation in Ethiopia, 1999.

The present levels of total area estimated to be under SSI is currently less than one percent of the total area currently being farmed. A similar analysis could be carried out on the basis of population and small-scale irrigation users.

Small-scale irrigation systems vary in type based on water source and distribution technology. These systems are diversion, spate, spring and storage systems and are defined as follows by (CRS, 1999):

- River diversion systems are off-take systems and are the most common form of irrigation system in Ethiopia. Diversion systems utilize natural river flow; however, regulation of river flow via a permanent structure in the riverbed is also a common practice to increase the off-take. Diversion systems abstract water over a sustained period of time and are able to deliver regular irrigation throughout the cropping regime. A key characteristic of diversion systems is the adequacy of water supply during the dry seasons and the ability to irrigate a dry season crop in addition to providing supplemental irrigation during the rainy seasons.

- Spate systems make use of the occasional flood flows of streams and operate during part of the year and there are two types of spate systems. The first referred as a run-off system, divert flood flows originating in high land areas. The second, most common on foothill sites in arid and semi-arid areas, divert flood flows originating in highland areas. Spate systems have proven difficult to rehabilitate due to difficulty of designing weirs to divert flows that change over a short period of time and which also resist structural damage from flood flows.
- Spring systems use small spring flows. Water is often shared with household and livestock users and stored over night in small reservoirs and emptied daily.
- Storage systems are earthen dam that store water for an extended period behind dams. In Ethiopia, storage systems are a recent introduction and pose technical and production challenges. It is important to consider the catchments flow and amount of sediment in designing storage systems. Cropping must be planned according to the amount of water stored and available for irrigation. Typically the irrigable area is much larger during the rainy seasons than during the dry season.
- Lift systems are extracting water from rivers, irrigation canals, reservoirs and wells. Lift systems have lower development costs. Manual or motorized pumps are used. Irrigated agriculture in the form of spate systems capturing the run-off from the Ethiopian highlands along the Red Sea Coast has been a land-use choice in the Horn of Africa for more than a thousand years (USAID, 1996). These early schemes were the precursors to the small scale, traditional irrigation schemes, including spate, diversion and very small storage systems, now widely practiced under local community arrangements throughout the country

2.8. Factors Affecting Irrigation Development Activities

The successes of SSI generally depend on the cooperation of larger range of government institutions and individuals, such as, for instance, the departments of irrigation, extension and rural works, local development agents. Unsurprisingly, development issues are interrelated and water resource developments by nature have interrelation with many factors. Consequently, irrigation developments are also determined by many factors for their success.

As stated by Brown Nooter (1995), the performance of irrigation schemes depends on: cropping pattern, market accessibility, maintenance and spare parts, social and political, and land tenure policies. Some of the major factors that negatively affect irrigation development based on previous empirical studies are:

A. Salinity: in the long term irrigation can increase the salt content of the soil and may cause the land not to be used for cultivation any more
B. Siltation, which is the process of filling canals and reservoirs with soil and sands leached from their respective up streams mostly due to poor catchments management (FAO, 1997).
C. Depletion of water resource and dependent life systems (i.e., ecological problem of surface and ground water development for marginal water quality areas).
D. Conflicts (e.g., trans-boundary, between upper and down stream users, between management and users, implementers and donors etc) (Desalegn, 1999).
E. Flood and erosion: appropriate surface drainages and effective operation are, therefore, critical for productive and sustainable irrigation in particular since canals are long, and it is difficult to adjust head diversions. Since some are vulnerable to excess water, irrigation-system must be responsive not only to the problems of little rainfall but also to problems of too much rain
F. Drainage challenges, renewability issues, seepages, canal lining, theft and vandalism of control structures (Donald Campbell, 1995).
G. Market prices for crops: irrigation projects may exhibit negative net present value (NPV) upon implementation due to change in market prices of goods from what is expected during the time of feasibility studies.
H. Change in interest rate: such huge investments are sensitive to cost of capital fluctuations.
I. Maintenance challenges and quality of design: the quality of design and maintenance system can also determine their sustainability.
J. Pest infestation and input shortages: are also some of the areas of concern due to their significant contribution as a threat.
K. Water born diseases: resulting from an irrigation projects are examples of diseconomies/ external costs imposed by the project to the society. In support of this, FAO (1986)

indicates that water related diseases and threats to flood plain ecosystem are other high environmental costs.

2.9. Review of Empirical Literature-Evidence from Ethiopia and outside Ethiopia

The following empirical studies relate to this study either in the methodology applied or the issues discussed.

Vandersypen, et.al (2006), by using descriptive and qualitative analysis evaluated farmer organizations of water management at tertiary level. The researcher targeted on two most significant activities of water management like water distribution and maintenance in Mali. During this study, the principles in use and their ability to resolve possible collective action drawbacks are assessed and conjointly the impact of the kind of infrastructure on the principles was examined. The information for this study was taken from a questionnaire survey of eighty nine farmers on fifty nine tertiary canals i.e. sub-lateral canals from five villages in Mali from June to October 2003.

The results of this study showed that rules are formulated solely on 30% and 20% of the canals for water distribution and maintenance, respectively. Furthermore, there is typically no consensus on rules among farmers. Additionally, monitoring and sanctioning mechanisms were absent. These results arose from individualistic behavior that caused issues on water distribution and maintenance for respectively 20% and 43% of the interviewed farmers. The study indicates that with water offer being abundant and also the infrastructure recently rehabilitated, organization of water management at community level is not continuously needed to avoid issues.

Fujile, Hayami and Kikuchi (2005) study factors affecting the success and failure of collective action for management of local commons in developing economies, using the case of irrigation within the Philippines. The study was based mostly on cross-sectional survey of forty six irrigators' associations in twenty five national irrigation systems under the command of the National Irrigation Administration over six provinces within the Philippines: Batangas, Cavity, Laguna, Occidental Mindoro, Oriental Mindoro and Quezon.

Results of Probit and OLS regressions were match with the hypothesis that collective action by water users for the operation and maintenance of irrigation system is difficult to arrange (a) where the water shortage rarely happens (b) where the distinction in water offer is large between upstream and downstream farmers (c) where irrigator's association is large in terms of service area and therefore the range of farmer beneficiaries among its territory, (d) where the area people is sparsely populated, involving low social interactions (e) where farm households have the choice of prepared exit from farm to nonfarm economic activities and (f) where farmers had historically practiced rain-fed farming with no previous expertise in managing communal irrigation systems.

Meinzen-Dick et.al (2000) has been identified factors that have an effect on organization of water users' associations and collective action by farmers in major canal irrigation system in India. The study was primarily based on qualitative and econometric analysis of a stratified sample of forty eight irrigation outlets in four irrigation systems (two every in Rajasthan and Karnataka). The study first examined the conditions under that farmers are most likely to create formal or informal associations at the outlet level. Results indicate that organizations are a lot of most likely to be shaped in larger commands, nearer to promote cities and in sites with non secular centers and potential leadership from school graduates and influential persons. Variety of beneficiaries at head or tail-end location did not have a significant impact. Lobbying activities are not a lot of probably where there are organizations; however organizations do increase the chance of collective maintenance work.

Gashaye Checkol and Tena Alamirew (2007) carried out a research on technical and institutional analysis of Geray irrigation scheme in west Gojjam zone, Amhara region, Ethiopia. To analyze the technical issues, the researcher has been identified performance indicators such as conveyance efficiency, application efficiency, water delivery performance and maintenance. The results of this study showed that the most and tertiary canals conveyance efficiencies were ninety two and eighty two, respectively. Several of the secondary and tertiary canals are poorly maintained and lots of the structures are dysfunctional. Moreover, application efficiency monitored on 3 farmers' plot located at completely different ends of a given secondary canal ranged forty four concede to fifty seven. Water delivery performance was solely seventy one implying a really substantial reduction from style of the canal capability. Moreover, the

maintenance indicators were evaluated in terms of water level charge 10(31.9%) and effectiveness of infrastructures11 (67%) shows that the scheme management was in a very poor form.

The result additionally showed that the 47% of the land initially planned is currently under irrigation whereas there was no amendments within the water provide indicating that the sustainability of the scheme is doubtful. The scheme has been managed by Water Users Association for four years, despite the actual fact that it had been made twenty seven years ago. Moreover, the study shows that the general performance of the Water Users Association in terms of managing the schemes was terribly poor. Furthermore, support services rendered to the beneficiaries were minimal. There have been only a few indicators that production was market oriented. Ironically, farmers did not acknowledge market as their drawback. Conflict resolution has been the duty of the Kebelles Council and Water Users Association has no legal authority to enforce its by-laws.

Shimelis (2006) conducted the study on institutional and management practices of small scale irrigation systems in Ethiopia. He took the case of two small scale irrigation systems in eastern Oromiya: Gibe Lemu and Gambela Terra. A total of 65 sample households were selected from 216 households. Interview with key informants, Water Users Association committee members and different experts were made. Focus group discussion was also held.

The result illustrates that the irrigation systems were unsuccessfully managed in terms of water allocation and distribution, conflict management and system maintenance, because of lack of well-established organizational and institutional conditions. The water user associations are not well organized and found to be weak to run the irrigation systems. Users have problematic social relation. Clearly defined and well-enforced land and water rights are non-existent at the operational level. Regarding technical resources such as improved seed that is adaptive to the situation of irrigation, labor and knowledge of irrigated agriculture (extension service and capacity building for irrigators) have not been met in the two irrigation systems.

Zeleke (2006) conducted a research on water rights and the process of negotiations among irrigators along Indris modern scheme in Toke Kutaye district, West Shoa zone, Ethiopia. The

findings of the research depicted that Indris scheme marked three different significant phases in its historical development. In these phases, exploration pertaining to water rights and processes of negotiations were found to be at their immature ground. Manifold water right rules emanating both from the customary and formal water acts have co-existed to direct the actions of users. In this regards, the theoretical orientations of pluralism in water right paradigms proved to coincide with the programmatic context of water users from the scheme. Furthermore, the main reasons for conflict occurrence in connection to irrigation water use and rights are decline in the volume of water resource, institutional failures to address the causes adequately, week observance on governing water right rules and increasing demands of users. As a result, negotiation process aiming to settle disputes was repeatedly initiated either by users, committee members (elder) or courts.

2.10. Conceptual Framework of the Study

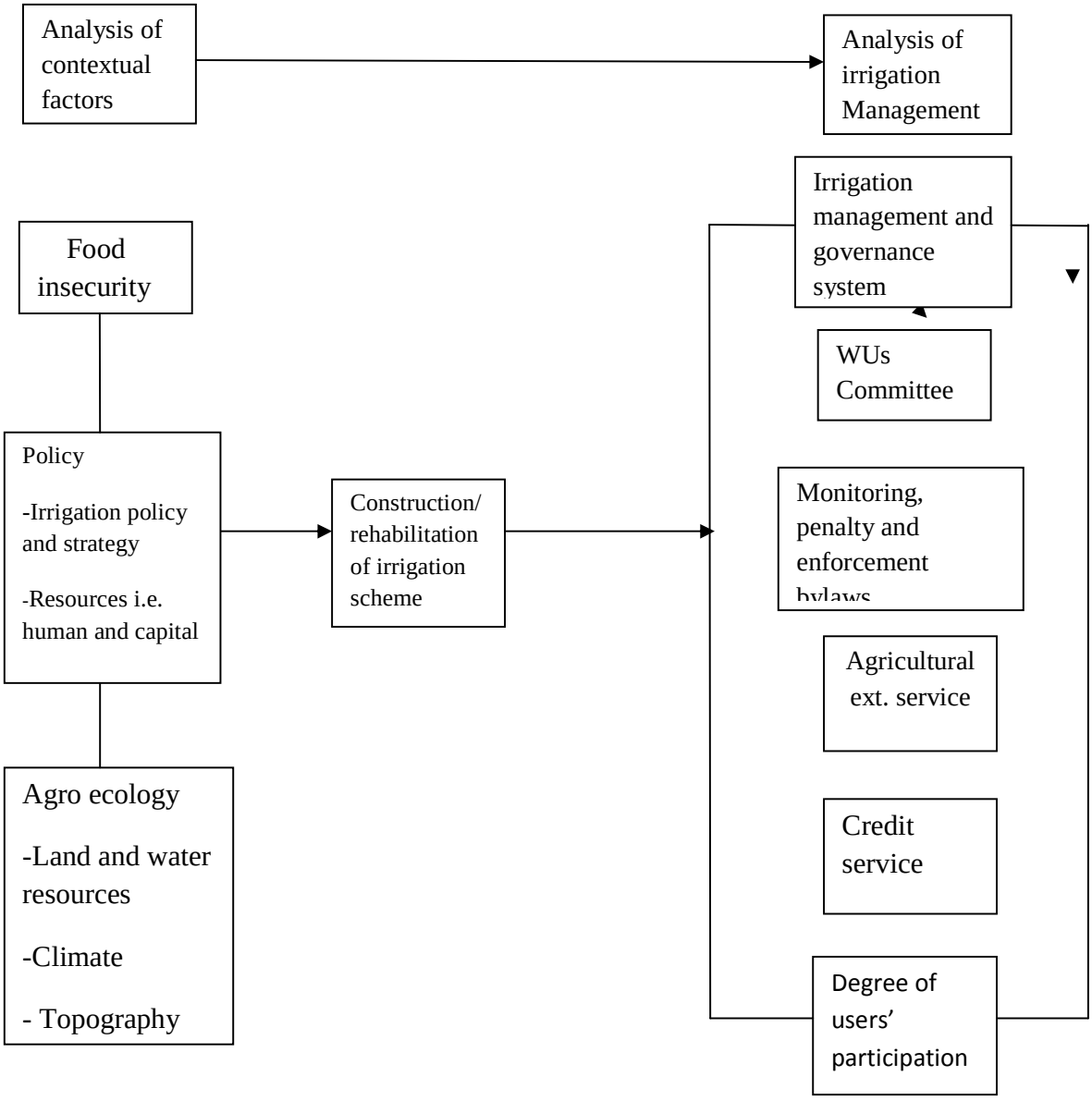


Figure 2.1: Conceptual Framework for Descriptive Analysis of Irrigation Management Practices. Partially Adopted From Woldeab, 2003

As it is seen from the above figure, before constructing or rehabilitating irrigation schemes, we should analyze contextual factors like food security of the community, agro ecology, resources available in the community and other policy related issues. Once we analyze these factors, we can going to construct or rehabilitate irrigation scheme. However, constructing of irrigation dam is not sufficient to have the positive effect on the livelihood of the farmers' rather once it is

constructed; we have to have followed up the management aspect of irrigation like water administration, conflict management, operation and maintenance of canals, water committee, by-laws and their enforcement, agricultural extension and credit services. Hence, the researcher is highly focused on the managerial aspects of irrigation.

CHAPTER THREE

METHODOLOGY OF THE STUDY

3.1. Description of the Study Area

3.1.1. Ethiopia

Ethiopia, with a total area of 1.14 million square kilometers, lies in the horn of Africa. It is a landlocked country situated in the horn of Africa lies between 3°30´ and 14°50´ North latitudes and 32°42´ and 48°12´ East longitudes and consists of nine independent regions and two city councils divided along ethnic lines. The country is sharing borders with Eritrea in the North, Djibouti and Somalia in the East, Kenya in the South and Sudan in the west (Haile, 2008).

Despite Ethiopia's location to within 15° of the equator, the Central and Eastern Highlands enjoy a temperate climate because of the moderating influence of high altitude, with a mean annual temperature rarely exceeding 20°C. The sparsely populated lowlands, on the other hand, typically have sub-tropical and tropical climates. Rainfall generally occurs in a 5-month unimodal rainy season from May to September in the western parts of the country and averages around 1,000 mm annually. The eastern and southern parts, on the other hand, have bimodal rainfall averaging annually from less than 200 mm in the semi-desert to 1,000 mm in the highlands. Rainfall can sometimes be erratic, especially in the eastern half of the country. Drought is a common feature in the country (MoWR, 2002).

Ethiopia is gifted with a considerable amount of water resources. The surface water resource potential is remarkable, but little developed. The country possesses twelve major river basins, which form four major drainage systems:

- The Nile basin (including Abbay or Blue Nile, Baro-Akobo, Setit-Tekeze/Atbara and Mereb) covers 33 percent of the country and drains the northern and central parts westwards;
- The Rift Valley (including Awash, Danakil, Omo-Gibe and Central Lakes) covers 28 percent of the country;

- The Shebelle-Juba basin (including Wabi-Shebelle and Genale-Dawa) covers 33 percent of the country and drains the southeastern mountains towards Somalia and the Indian Ocean;
- The North-East Coast (including the Ogaden and Gulf of Aden basins) covers 6 percent of the country (AQUASTAT: http://www.fao.org/nr/water/aquastat/ Accessed on 23 October, 2010).

According to the Water and Power Consultancy Service (WAPCOS), Ethiopia could potentially develop irrigation over 3.73 million ha of farmlands. Nevertheless, the total area to date under irrigation is estimated to be about 160,000 ha, including the area under traditional irrigation. Irrigated agriculture has realized only 4.3 per cent of its estimated potential. In terms of output, irrigated agriculture accounts for approximately 3 per cent of total food crop production (MoWR, 2002).

Although Ethiopia is endowed with a substantial amount of water resource, Agriculture in is greatly dependent on rainfall, which is highly inconsistent, both spatially and temporally. In many parts of Ethiopia, agricultural development is hindered by persistent droughts, which over the years have increased both in frequency and severity in many parts of the country. In the past 30 years the drought incidence has become common in a pattern of every two to three years cycles (Haile, 2008). Yet, Ethiopia, faced with rising population pressure, has remained a food-deficit country since the 1970s. In 1999/2000, for example, Ethiopia imported over 800,000 tones of grain in the form of food aid. If the country is to achieve its stated aims of food self sufficiency and food security, the current production shortfalls call for drastic measures to improve productivity of irrigated and rain-fed agriculture (MoWR, 2002).

3.1.2. Tigray Region

Tigray is the northern most state of Ethiopia located between latitudes $12^0$15'N and $14^0$50'N and longitudes 36027'E and 39059'E. It is bound in the north by Eritrea, to the west by The Sudan and to the east and south by the Afar and Amhara regional states of Ethiopia respectively (Fredu, 2008). According to the Central Statistical Agency (CSA) of Ethiopia published in 2007, Tigray has an estimated population of 4,565,000 of which 80.5 percent are estimated to be rural inhabitants, while 19.5 percent are urban. With an estimated area of 50,078.64 square kilometers,

the region has an estimated density of 91.2 persons per square kilometer (CSA, 2007). The study was conducted in the eastern zone of Tigray, Kilte-Awlalo woreda.

3.1.3. Kilte-Awlalo Woreda

Kilte-Awlalo Woreda is located in Eastern zone of Tigray, at about 45 Km to the north of Mekelle along the Mekelle-Adigrat main road. The woreda has 18 rural administrative kebelles called 'Tabias'. According to the data obtained from the Woreda Agricultural and Rural Development office, the total land of the woreda is 101,758ha. The land use pattern is sub-classified as, cultivated land 21,620ha, forest land 44,134ha, and grazing land 7930.85ha and the rest 28,073.15 is either unproductive or occupied by houses, roads, water ways etc. According to the Woreda Agricultural and Rural Development office in 2010/11, the woreda has an estimated population of 114,001 of which 55,623 are estimated to be male inhabitants, while 58,378 are female inhabitants.

The study was conducted in Genfle kebelle administration of Kilte- Awlalo Woreda in Eastern Zone of Tigray Regional State. According to the data obtained from the Woreda Agricultural and Rural Development office, the total land of the kebelle[2] is 2423.48ha.and the kebelle constitutes 3 main villages (Queshets); viz. Endasilassie, Dengolo and Qorrir. According to the Woreda Agricultural and Rural Development office, the total cultivated land of the kebelle is estimated to be 1286.85ha. and the rest 101.63 ha. is occupied by roads, different institutions etc. The total population of the kebelle in 2010/11GC is 6398 of which 3019 are males while 3379 are females.

With this regard, information obtained from the Klite- Awlalo Agriculture and Rural Development Office and local development agents indicate that the agricultural extension services provided to the community in Qorir SSI Scheme mainly include crop and livestock production, natural resource management and irrigation. There are 4 extension agents or development agents assigned for Genfel Kebelle Administration.

There is one farmers training center (FTC), the Genfel FTC, located in the outskirts of Wukro town, which is located at the center of the Genfel kebelle Administration. Although the distance of the FTC from Qorir SSI Scheme is about 7-10KM, it is said to be a central location in order to

[2] is the lowest officially recognized administrative unit

serve its 3 main villages. The main function of the FTC is provision of extension services through training and demonstration in order to transfer improved agricultural technologies and give adequate services with in reaches of individual farmers. It also serves as information and exhibition center to enable farmers' easy access to relevant information and innovation in agriculture. According to the information obtained from WARDO, the FTC did not provide training on water management and business/ marketing so far.

3.1.4. Qorir Small Scale Irrigation Scheme

- **Location of Qorir SSI Scheme**

Qorir SSI Scheme is located near Qorir village within Genfle Kebele Administration of Klite-Awlalo Woreda in Eastern Zone of Tigray. Qorir village is also close to Wukro town, the administrative centre of Klite-Awlalo woreda, about 45 Km North of Mekelle along the Mekelle-Adigrat main highway. One may find Qorir SSI Scheme and the small earth dam supplying its water (Qorir Dam), driving north from Mekelle and turning right at about 3 killo meter just before reaching Wukro town; and reaches the scheme at 2.2 KM east of the main highway. The command area of the scheme itself begins from the edge of the main road and extends up to the foothills of Qorir mountain chains where Qorir Dam is positioned. In terms of geographical coordinates, the site can be located at 0566124E and 1519682N.

- **History of Qorir SSI Scheme**

In 1983 E.C, Co-SAERT (Commission for Sustainable Agriculture and Environmental Rehabilitation in Tigray) built an earth dam near Qorir village to collect the runoff from the seasonal rainfall. It was intended to provide irrigation water for the village community and it was named "Qorir Small Scale Irrigation Scheme". The dam meant to irrigate over an estimated 100 hectares of the vast command area along the downstream. Nevertheless, irrigated areas from the water collected in the dam have never exceeded an estimated 72 ha of irrigated area during years of its best runoff yields.

- **Organization of users for self-management of Qorir Small Scale irrigation**

In accordance with the policy frame work for SSIS development in Ethiopia, management and operation of SSIS is the joint responsibility of the state irrigation agency, cooperative promotion and input supply disks, districts and village level administrative and legal entities and farmers and their organizations. Along with the completion of irrigation development projects carried out by Co-SAERT in many parts of Tigray around late '90's; the need for devolution of responsibilities to the lowest appropriate level through transfer of (small scale) irrigation management to the intended beneficiaries of the irrigation scheme was came. Qorir SSI scheme being one of such projects in Klite- Awlalo woreda, the woreda administration laid down the formal structure to facilitate the process for transfer of the irrigation water management activities to local farmers (beneficiaries).

Accordingly, the woreda administration office issued a letter addressed to Genfel Kebelle administration on the subject of a directive for utilization and management of irrigation schemes, which was enclosed with the letter; Ref.No.906/26/92, dated 10th October 1999. The letter was advising Genfel Kebelle Administration regarding issuance of the directive for utilization and management of irrigation schemes; and, for the letter to implement/ adopt it in the management of the irrigation scheme within its auspices (e.g. Qorir SSI Scheme). The letter was also copied to Wukro woreda court, social courts in 5 Kebelle Administrations and woreda justice office, which imply that these judiciary bodies are providing their supports of legal enforcement for implementing the regulations described in the directive.

Among other things, the directive indicates that the two committees will be formed as irrigation committee and water committee to function at kebelle administration and Qushet (village) levels respectively. The two committees' roles and responsibilities are defined to involve, respectively, as overseeing overall governance and management of irrigation schemes in the Kebelle Administration and the management of (small scale) irrigation activities with in a scheme.

According to the directive, the irrigation committee to be formed at Kebelle Administration level was described as comprising pre-designated members including a chairperson (assumed by the Kebelle Administration chairperson), a vice chairperson (Kebelle Administration Development

committee chairperson), a secretary (a representative of DAs in kebelle administration) and other 4 committee members including the Kebelle administration's propaganda chief, SAERT engineer, SAERT site-mobiliser, chairperson of the service cooperative and the chairpersons of water committees of the irrigation schemes in the kebelle administration. Currently, there is no trace of the irrigation committee, except the water committee.

The water committee, on the other hand, is to be formed through election by the irrigation beneficiary community members every year to manage the irrigation. The first of the water committee was formed through election by community members in Qorir SSI Scheme at the time the Qorir dam was completed in 1997G.C.

The members of the committee are: Chairperson, Vice chairperson, Secretary, Treasury, Auditor and two operators. The system has a by-law in the kebelle judiciary (social court) written and legalized in 1992 E.C. The directive defines the roles and functional procedures of the water committee as well as the rights and obligations of the irrigation beneficiaries; along with the types of offences that are considered punishable and subsequent fines.

Accordingly, the water committee is responsible to manage the scheme and its main roles include protecting the infrastructure from being damaged (misuse or otherwise), facilitating scheduled water use by the irrigation beneficiaries and monitoring any attempt involving violation of established regulations by users such as defaulting agreed water access schedules and trying to divert water while it is not their turn. In addition to the above mentioned roles, the water committee is also responsible for resolving disputes related to water, land and maintenance based on the by-law.

The water committee and the water users groups were formed in the hope for good management of the irrigation scheme. All water users are organized in to 13 groups (Budens), each group comprising13-32 members. The organization of irrigation beneficiary farmers into groups is based on the relative position of their plots relative to the headwork. Accordingly, it starts from those who own plots at the headwork (group 1) and continues towards the downstream users. The size of each group is based on the cumulative land size owned by each group members.

3.2. Data Type and Data Source

This research was conducted both qualitatively and quantitatively and based on both primary and secondary data.

3.2.1. Primary Data

The primary data were collected by employing triangulation method such as key informant interview using semi-structured checklist, focus group discussion, expert interview; semi structured household questionnaire and observation of events in the irrigation scheme. The enumerators for the data collection were selected on the basis of their educational background and their ability of the local language. A two day's training was given to the enumerators about the method of data collection and the contents of the questionnaire. And then, pretest was conducted. Hence, based on the pretested result, the questionnaire was redesigned.

3.2.2. Secondary Data

Secondary information that could supplement the primary data was collected from published and unpublished documents obtained from different sources. These included policy statements, proclamations and regulations, project appraisal documents, reports and past case study papers on irrigation. The study started with brief review of the regional and national irrigation policies, the policy and legal frameworks regarding irrigation, land and water rights.

3.3. Data Collection Techniques/ Instruments

3.3.1. Questionnaire

The data required for this study were collected from the total beneficiaries of Qorir Small Scale irrigation scheme using a semi structured questionnaire and the questionnaire was translated into Tigrigna, a local language.

3.3.2. Key Informant Interview

Key informant interview was conducted to generate general understanding of the irrigation system, including pre-intervention situation, historical background of the irrigation scheme, and the major managerial problems in the irrigation scheme. The information obtained through key

informant interview was also used for modifying questionnaire developed for the household interview and to focus on the formal study more on the variables, which are more relevant to irrigation management and irrigators. Key informants include elderly and knowledgeable irrigators, development agents (DAs), woreda irrigation officials and professionals.

3.3.3. Interview

In-depth Interview with checklists was held with water users' committee members and some irrigators to gather data on the issue of management activities of the water committee and problems that the committee is facing in the irrigation management, including conflict management and water allocation schedule.

3.3.4. Focus Group Discussion

The primary data collected from sample farmers were also further enriched by additional information gathered through focus group discussion. Focus Group Discussion was also held with irrigators to generate detailed information especially on conflict and its resolving mechanisms that is taking by the water committee. The researcher employed a person who runs the focus group discussion in the local language. A total of 7 irrigators were selected purposively based on the information obtained from key informants and of them two were female farmers. Farmers from the head-end to the tail-end areas of the water source were included in group discussion because the location of the farm layout may result in conflict on the issue of water sharing among irrigators.

3.4. Target Population

The number of beneficiaries of Qorir Small Scale irrigation scheme depends on the amount of annual rainfall or the volume of water runoff into the reservoir (dam). Hence, according to Kilte-Awlalo Woreda Agriculture and Rural Development Office in 2010 G.C., the number of beneficiaries of Qorir Small Scale irrigation scheme was 120 in number. And for this study, all beneficiaries were taken and studied.

3.5. Data Analysis

Both quantitative and descriptive analysis techniques were used for data analysis. The data generated through household questionnaire was analyzed by employing the computer Software known as Statistical Package for Social Science (SPSS Vs. 16.0) and Stata 10. The descriptive statistical methods such as frequency, percentage, mean, and standard deviation and X^2-statistic were used for analyzing the data generated through household questionnaire.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

This chapter is concerned with the presentation, analysis and interpretation of data gathered via primary sources such as questionnaire, interview and focus group discussion and secondary sources such as published and unpublished documents.

4.1. Socio-demographic characteristics of irrigators

Table 4.1: Sexes of Household Heads and Their Participation in the Affairs of the Scheme

Do you participate in the affairs of the scheme?		Sex of the household head		
Responses		**Male**	**Female**	**Total**
	Yes	**98**	**15**	**115**
	No	**2**	**5**	**5**
	Total	**100**	**20**	**120**

Source: Field survey, 2011

As it can be vividly seen from table 4.1, of the total 120 household heads of the irrigation beneficiaries, 83.3% were headed by males and 13.7% were headed by females. The above table shows that almost all male beneficiaries participate in the affairs of the irrigation scheme. Of the 20 female household heads, 5 female beneficiaries do not participate in the affairs of the scheme. In Ethiopia, large amounts of women's time is spent in household reproduction activities such as gathering firewood, collecting water, preparing food, caring of children, other household duties and their responsibility as household heads along with their farm activity and these may prevent them in participating in the affairs of the scheme.

Table 4.2: Age and Level of Education of the Household Head

		Level of Education of the Household head					Total
		Illiterate(can't read and write)	Can only read and write	Grade 1-4	Grade 5-8	Grade 9-12	
Age of the Household head	18-28	4	2	3	3	2	14
	29-38	7	4	9	8	0	28
	39-48	16	6	10	3	0	35
	49-58	11	4	7	4	0	26
	59-68	5	3	2	0	1	11
	above 68	1	5	0	0	0	6
Total		**44**	**24**	**31**	**18**	**3**	**120**

Source: Field survey, 2011

Table 4.2 shows the summary of age and level of education of the households' heads in Qorir Small Scale Irrigation scheme. Age of the household head, 29.2% was in the range of 39-48 years. Regarding the level of education of the household head, the majority (36.7%) were illiterate (can't read and write). In addition, the mean household size of the users was 5.53. However, it was noted that family size varied between 1 and 11 persons with standard deviation of 2.23.

4.2. Irrigation Management Practices Within Qorir Small Scale Irrigation System

In the study area small scale irrigation management activities include water use activities such as allocation and distribution, control structure activities which refers to construction, operation and maintenance and organizational activity which includes activities like resource mobilization, conflict resolution and decision making.

4.2.1. Water Management

4.2.1.1. Water Allocation

Water may be supplied on a continuous or a rotational basis in which the flow rate and duration may be relatively fixed. In those cases, the flexibility in scheduling irrigation is limited to what each farmer or group of farmers can mutually agree upon within their command area. With this regard, Qorir small scale irrigation is adopting rotational system which are secondary canals receive water by turns and the individual farmers within a given area receive the water at the pre-set time.

Based on the amount of the water stored in the reservoir each year after the rainy season, the size of irrigable area is determined by the local beneficiaries with the close assistance of woreda experts. Then after those farmers whose farm land included in the delineated area will group into several groups and elect group leaders, the beneficiaries discussed with close assistance of woreda experts and development agents, and develop the rotational system by setting sequential irrigation turn of each group starting from the head end of the water source.

In the study area, the water committee is in charge of water allocation and coordination of rotational water distribution. Irrigation agronomists and Development Agents are also supposed to provide technical assistance to water committee in water allocation, in preparing the annual schedule of water distribution and in defining the water rights of members based on study on water requirements of different crops and irrigable plot area and measurement of the yearly water supply. Monthly, the water committee calls a meeting and coordinates maintenance and canal cleaning activities.

Water allocation and rotational schedule, which was prepared and implemented by the water committee has got limitations in terms of its implementation. The focus group discussion with beneficiaries revealed that in terms of implementation, water allocation is based on guess. Beneficiaries do not know when to irrigate their farm and the communication that inform who is going to irrigate next (whose turn is next) is verbal and not transmitted to each farmer. As a result, farmers come to irrigate their farm after their turn is passed and the operator is forced to release the water even for one farmer. Amount and time of water supply are not defined with the water requirement of different crops grown and area of irrigable plots managed by households.

This resulted in a major problem in the implementation of rotational distribution of irrigation water.

4.2.1.2. Water Distribution

Table 4.3: Responses Related to Getting Enough Irrigation Water and Reasons for Not Getting Enough Irrigation Water

Do you get enough water?		**Frequency=120**	**Percent**
Responses	Yes	46	38.3
	No	74	61.7
	Total	**120**	**100**
What are the major reasons for not getting enough water?		**Frequency N=74**	**Percent**
Reasons	Water scarcity	48	40
	Poor coordination of water distribution	13	10.8
	Water theft	9	7.5
	I am tail-end irrigator, water does not reach	4	3.4
	Total	**74**	**61.7**

Source: Field survey, 2011

The study identified that the scheme has water committee. The water committee is responsible for coordinating the water distribution. The water committee nominates two individuals who are responsible to open the water gate as per the program of each of the groups (formed based on their farm location). The monthly salary of each gate keeper is 45 birr and their responsibility is, in addition to opening and closing of the gate, they are responsible for keeping turn and protecting water theft. Each group gets water based on time limit (scheduling).

According to table 4.3, 38.3% of beneficiaries said that they get enough water when needed for their agricultural activities. The table also clearly shows a significant number of water users (61.7

percent) said that they have faced a problem of water shortage in the irrigation scheme; they said that they could not get enough water for their farm activities when they need. Of the 61.7 percent of irrigation water users who complained not to get enough water, 40 percent said that the shortage is due to water scarcity. This problem may be created due to the erratic nature of annual rainfall, evaporation, the presence of plants around the earthen canal, the weakness of the gate keepers in keeping the farmers' water use turn, negligence of the water committee in coordinating water distribution, beneficiaries use the water in the reservoir for their livestock consumption, the presence of holes created by rates in the command area and there are under age children assigned to irrigate the farm in the study area and they could not manage the job so it is means of water losses. These in turn result in water scarcity in the command area. Moreover, water scarcity, poor coordination of water distribution by the water committee and water theft were the 1st, 2nd and 3rd most important problems that constrained the supply of adequate water in the command area of the irrigation scheme respectively.

Table 4.4: Farmers' Response on Major Causes for Water Scarcity

If there is water scarcity, what are the most important causes for you?		**Frequency N=48**	**Percent**	**Rank**
Causes	Seepage loss	9	7.5	3rd
	Increasing number of users	3	2.5	4th
	Declining level of water from the reservoir	24	20	1st
	Poor scheduling of distribution	12	10	2nd
	Total	**48**	**40**	

Source: Field Survey, 2011

According to table 4.4, 20 % of the respondents expressed that declining level of water from the reservoir was one of the factors responsible for water scarcity in the command area. This may be due to shortage of rainfall and high evaporation in the study area. The other cause of water scarcity in the command area is seepage loss (7.5%). This may be due to the fact that in the study area except some parts of the main conveyance canal made from cement (150 meter), the secondary canals are earth canals and malformed due to lack of timely and proper maintenance

activities. As a result of this excessive seepage was observed during the study time. Moreover, poor coordination of scheduling, inadequate coordination of water distribution and increasing number of water users in the command area have had contribution for the problem of water scarcity in the study area.

Table 4.5: Water Users' Opinion about the Performance of Water Committee in Water Distribution

What do you feel about the performance of the water committee in the management of water distribution?		**Frequency N=120**	**Percent**
Opinions	Enough water is not received due to misutilization of water (adequacy)	63	52.5
	Water is not received when needed (timeliness)	42	35
	Water distribution is unfair (equity)	15	12.5
	Total	**120**	**100**

Source: Field survey, 2011

According to table 4.5, more than half of the water users (52.5 percent) witnessed that they could not obtain enough water due to misutilization of water by some careless irrigators. The other 35% and 12.5% irrigators said that they could not receive water when they need and water distribution is unfair respectively. This is because according to the information obtained from the water committee chairperson, special emphasis is given to vegetables that are any farm covered with vegetables can irrigate whenever the plant required without following the rotation. As a result, farmers who have plot covered with crops and perennials may not get water when they need. The water committee consists of seven members to coordinate and control water distribution in the command area of the scheme. However, according to the most important performance indicators in the distribution of irrigation water designed by World Bank in 2000 include adequacy, timeliness and equity in the supply of water, the water committee was found to be inefficient in managing the water distribution in terms of the three performance indicators.

Table 4.6: Farmer's Responses about Socioeconomic Groups That Get More Water in the Irrigation Scheme

If there is unfair distribution of water, which socioeconomic groups get more water in the irrigation scheme?		Frequency N=15	Percent
Groups	Farmers with large family	6	5
	Farmers with large farmland	7	5.8
	Rich farmers who grow perennials	2	1.7
	Total	**15**	**12.5**

Source: Field survey, 2011

According to table 4.6, 5.8% of the beneficiaries said that farmers with large farmland obtained more water because they have large farm land and there is no time limit how long each farm has to irrigate. As a result of the above mentioned reasons, farmers having small farm land size are suffering from lack of irrigation water. 5% of beneficiaries also complained that farmers with large family received large volume of irrigation water and the rest 1.7% were reported that rich farmers who grow perennials got more water. Moreover, during the focus group discussion the beneficiaries also indicated their disappointing experience that the performance of the scheme has been declining over the past years to a level where it is no more making a difference in their farming practices. These problems happened due to the weak performance of the water committee in water distribution. The prevalence of unfair distribution of irrigation water that means certain socioeconomic groups obtains more water for their farm activities than others. As a result, the target community could not fully and equally benefit from the water as it had been anticipated.

Table 4.7: Users' Opinion about Major Management Problems Related to Water Distribution

What are the major management problems related to water distribution?		*Frequency N=120*	*Percent*
Opinions	Sanctions not imposed against illegal water users	52	43.4
	Rotation does not accomplish equality	21	17.5
	Rotation is not strictly implemented	19	15.8
	Poor coordination of water distribution by Water committee	28	23.3
	Total	**120**	**100**

Source: Field Survey, 2011

Table 4.7 presents users' perceptions about the major weaknesses of the water committee on water management. Of the total users, 43.4% reported that Sanctions are not imposed against illegal water users i.e. irrigators that extracted and used more water by abusing turns. Some of the illegal water users may be intimate friends or relatives of the water committee members. Hence, sanctions may not be imposed on them. 23.3% of the beneficiary farmers stated that they were not able to obtain water in a reliable manner because of poor coordination of water distribution by water committee. The research result also shows that 17.5% and 15.8% of irrigation users did not obtain the quantity of water that they need because, among others, rotation does not accomplish equality. This may be due to the fact that rotation is based on the type of crops and vegetables planted and the size of the farmland in the command area as a result of this rotations were not strictly implemented . Moreover, the study shows that the general performance of the Water Users committee in terms of managing the scheme was terribly poor.

4.2.2. Conflict and Conflict Management

With regard to Qorir SSI scheme, water users, water committee members and key informants explained that conflicts arising from water allocation and distribution are a common phenomenon among irrigators within and between groups. Hence, according to Gashaye (2007) institutional arrangement on irrigation is required to overcome problems related to irrigation water as a

common property resource, to provide incentives to disciplined members, disincentive to free riders/ violators.

Table 4.8: Beneficiary Farmers' Response to the Presence and Causes of Conflict over Irrigation Water

Have you ever faced any conflict over irrigation water?		**Frequency N=120**	**Percent**
Responses	Yes	72	60
	No	48	40
	Total	**120**	**100**
What are the causes for water conflict?		**Freq. N=72**	
Causes	Water theft	17	14.2
	Water scarcity	31	25.8
	Competition due to increasing number of water users	8	6.7
	Lack of proper control of water distribution	16	13.3
	Total	**72**	**60**

Source: Field survey, 2011

Table 4.8 shows the results of household questionnaire that majority of beneficiaries, 60% acknowledged the presence of conflict arising from distribution and allocation of irrigation water. They mentioned water scarcity, water theft, lack of proper control of water distribution and competition due to increasing number of water users as the prominent factors for water conflict. 25.8% of the beneficiaries reported that due to the erratic nature of rainfall and the declining of volume of water conveyed in to the dam (water scarcity); there had been intense competition and conflict over water. 14.2% beneficiaries stated that water theft has also been one of the prime factors for water disputes within groups and between groups. Informants also expressed that lack of enforcement of bylaws for water allocation has also been one of the most important constraints that led to unnecessary water disputes. They also expressed that '*the stated bylaws are good in written form but when we see them in practice, they are not well applied. Some irrigators break*

the bylaws and commit water theft but the penalty is not proportional to the mistakes that they made. This is because the violators build a strong relationship with the water committee members'.

The remaining 13.3% and 6.7% of irrigators said that the conflict arises due to lack of proper control of water distribution and competition (increasing number of water users') respectively. Furthermore, the beneficiaries ranked the causes of water conflict as water scarcity, water theft and lack of proper control of water distribution as the first, second and third respectively.

Table 4.9: Farmers' Response on Conflict over Irrigation Water by Their Farm Location

Have you ever faced any conflict over irrigation water?		**Where is your farm location from the water source?**				
		Upper-catchment	**Middle-catchment**	**Lower-catchment**	**Total**	
Responses	**Yes**	15	23	34	72	X^2-value
	No	35	11	2	48	37.3747*
	Total	**50**	**34**	**36**	**120**	

Source: Field survey, 2011 *=Significant at 1%

Table 4.9 shows that water users in the Upper-catchment area of the irrigation scheme were faced disputes over irrigation water. From this we can understand that conflict over irrigation water is becoming severe when we go from Upper-catchment to Lower- catchment of the water source. As a result of this, most Lower- catchment beneficiaries responded that they faced conflict over irrigation water. When a farmer's farm location is far from the water source, the probability of getting enough irrigation water is low. This in turn results in water scarcity, the major cause for water conflict. The chi-square test also revealed that conflict over irrigation water and farm location from the water source has a significant relationship at 1% significance level.

Table 4.10: Farmers' Opinion about the Performance of Water Committee in Resolving Conflicts in the Irrigation System

How do you evaluate the performance of the water committee in resolving conflict?		Frequency N=120	Percent
Opinions	They take immediate actions on cases	70	60
	Conflict management has been improved	4	3.3
	They suspend cases	44	36.7
	Total	**120**	**100**

Source: Field survey, 2011

Table 4.10 presents that a significant number of beneficiary farmers (60%) responded that the water committee takes immediate actions on cases to resolve conflicts when they arose. The rest 36.7% said that the water committee suspended cases. This may be due to the fact that whenever there are violators, the water committee takes such perpetrators to kebelle social court. Nevertheless, the court always demands witnesses for the offences done. Because of these procedural problems, cases may be suspended. Informants also indicated that when fellow farmers who had witnessed the wrong doing (the wrongdoer in action) are asked to stand as witnesses; they decline from cooperating; in case the perpetrator might resent against them. Most beneficiaries of the scheme do not want to risk consequences from such feelings of resentment from any one endured legal actions for being found guilty. So, the committee often finds itself powerless to ensure observance of the regulations set for the irrigation water management.

3.3% of beneficiaries said that conflict management has been improved in the irrigation system. This is due to the presence of support from development agents on the issue of conflict management. The researcher also conducted an interview with the water committee chair person about the enforcement of the by-law on the guilty farmers. The interview revealed that for instance, if the person is guilty on water theft, he/she will be penalized based on the appearance of the plant. If the plant is endangered due to water scarcity and if the person is trying to save the life of the plant, he/she will be penalized less than the expected penalty. If the case is beyond the capacity of the water committee, it will be submitted to the kebelle social court. He added some

ideas through proverb that *"Jib ende hageru yichohale"* meaning they are trying to solve the problem accordingly with the weight of the case.

4.2.3. Operation and Maintenance of the Irrigation System

According to the information obtained from the water committee members, maintenance of the canals are undertaken by mass mobilization, on average, once in a month and according to their by-law those beneficiaries who are absent in the maintenance work will be penalized up to 50 ETB based on the wage of daily laborer. In addition to this, rebuilding of temporary diversion structures are done by the users own initiatives annually; usually at the beginning of the irrigation season. Moreover, farmers undertake canal cleaning and system maintenance activities monthly under the leadership and coordination of the water committee and local development agents. The most important reason they suggested for the maintenance and farmer commitment was the role of irrigation in the life of farmers in the area. Nevertheless, the irrigation beneficiaries defer major maintenance works that require input of expert skills and industrial product (e.g. cement) to the government agencies to do it for them.

In order to look after violators, the committee has hired two guards who are paid through contributions of the irrigation beneficiaries. Each of the irrigation beneficiaries owning a plot size of 0.125ha ($1/8^{th}$ of a hectare) contributes ETB 10/ year. The contribution varies according to the plot size of individual beneficiaries. That is, it could be higher for those holding plot size more than 0.125ha or lower for those holding less size of land. The money remaining after paying the salaries of the guards is used for minor maintenances of the irrigation infrastructure.

Table 4.11: Beneficiaries Opinion about the Maintenance of the Scheme

How do you evaluate the maintenance of the scheme?		Frequency N=120	Percent
Opinions	Very good	20	16.7
	Good	72	60
	Acceptable	19	15.8
	Poor	8	6.7
	Very poor	1	0.8
	Total	**120**	**100**
If your answer is poor or very poor, what are the causes?		**Frequency N=9**	**Percent**
Causes	Siltation	**3**	2.5
	Poor imposition of sanctions on reluctant users	**2**	1.7
	Absenteeism of some members on maintenance days	**2**	1.7
	Breaching of canals by illegal water users	**1**	0.8
	Poor coordination of maintenance activities	**1**	0.8
	Total	**9**	**7.5**

Source: Field survey, 2011

Qorir small scale irrigation is furrow irrigation system which comprises some on and off-farm infrastructure which perform several important functions like turning the flow to a field on and off, conveying and distributing the flow among the fields. The main canal with length of 150m is lined and is performing in a good condition. This canal feeds two secondary canals and one tertiary canal. Drops in the main canal are also in a good condition. But the secondary canal is not in a good condition. With reference to Table 4.11 a significant number of beneficiaries (60%) responded that maintenance of the irrigation scheme is in a good condition. However, according to beneficiaries who said the maintenance of the scheme is poor and very poor (7.5%), siltation (2.5%), poor imposition of sanctions on reluctant users (1.7%), absenteeism of some members on

maintenance days (1.7%), breaching of canals by illegal water users (0.8%) and poor coordination of maintenance activities (0.8%) were some of the major causes.

4.3. The Contribution of the Water Committee in the Irrigation Scheme

The water committee is to be formed through election by the irrigation beneficiary community members every year to manage the irrigation. The first of the water committee was formed through election by community members in Qorir SSI Scheme at the time Qorir dam was completed in 1997G.C.

The members of the committee are: Chairperson, Vice chairperson, Secretary, Treasury, Auditor and two operators. The system has a by-law in the kebelle judiciary (social court) written and legalized in 1992 E.C. The directive defines the roles and functional procedures of the water committee as well as the rights and obligations of the irrigation beneficiaries; along with the types of offences that are considered punishable and subsequent fines.

Accordingly, the water committee is responsible to manage the scheme and its main roles include protecting the infrastructure from being damaged (misuse or otherwise), facilitating scheduled water use by the irrigation beneficiaries and monitoring any attempt involving violation of established regulations by users such as defaulting agreed water access schedules and trying to divert water while it is not their turn. In addition to the above mentioned roles, the water committee is also responsible for resolving disputes related to water, land and maintenance based on the by-law.

4.4. Constraints of Users for Self-Management of the Irrigation Scheme

Key reflections captured during focus group discussion with irrigators, interview with key informants and interview with the water committee members on the constraints of users for self-management of the irrigation are discussed below:

- **Rainfall shortage and variability affecting irrigated agriculture**

The reduced quantity and irregularities of the annual rainfall did not only affect the rainfed cultivation but also caused reduction of irrigated land due to shortage of irrigation water in the dam (reservoir). This has been a repeated phenomenon at Qorir SSI Scheme following a low rain fall season during most of the past years. The effect of low rainfall, and thus low runoff yield, has been a decline in the irrigable area. As a result, the target community could not fully benefit from the scheme. Among other things, the extreme scarcity of water supply adversely influences farmers' participation in water committee or other formation of coming together for collective benefits. Therefore, under such situations each family may be forced to fend for themselves.

- **Capacity limitations in irrigation agronomy and water management**

The limitation in the availability of water is not only caused by low rainfall but also it is lack of capacity for sustainable management and use of the available water. The extension supports in water management and irrigation agronomy are weak due to limitations in technical capacity. Research and extension support in farm management, irrigation water management, irrigation agronomy and marketing is poor or with inadequate coverage. Even if there is FTC in Qorir, it does not provide any training about water management. Failure to give full support for the establishment of WUAs is another drawback of the extension system.

- **Disfavoring market system and related constraints**

One of the main challenge of farmers in relation to market is that they often sale their products at lower prices as decided by the merchants. This is mainly because of the marketing system and unbalanced bargaining power involved in the transaction process, which usually disfavors farmers. Despite the expressed constraints of community members regarding the inconveniences related to marketing of their products, the available services of FSC (Farmers' Service Cooperative) do not include marketing of agricultural products. The main reason that the FSC is not providing agricultural marketing services is because of its limited capacity.

- **Prevailing of dominant figures in the water committee**

Since 1997G.C (Qorir dam was completed), there is an election of the water committee by the beneficiaries every year to manage the irrigation. Nevertheless, some of the initial members are

still serving as the water committee members i.e. they have not been fully changed since the initial election except a few replacements of individual committee members who left the committee for different reasons. This reflects a sign of dominant figures prevailing in the committee.

- **Absence of a Water Users Association(WUA)**

Despite the existence of a water committee and its efforts to manage the SSI Scheme, it does not have the required strength to effectively manage and ensure realization of a sustainable livelihood for the beneficiaries as well as contributing to the socioeconomic development of the community in the area. In addition, the absence of a WUA presents a major gap in terms of having formal institutional arrangements for governing the irrigation scheme. Had the WUA existed, there would have been a creation of reasonable product price for the products produced.

- **Provision of fertilizer and improved seeds**

Most of the focus group discussants and key informants have indicated the availability of fertilizers during both irrigated and rainfed cropping seasons despite their high prices. In addition, inadequate provision/ supply of improved seeds both in quality and quantity are one of the constraints farmers raised during the FGD.

4.5. Major Challenges that Hinder the Sustainability of the Irrigation Scheme

Numbers of factors hinder the sustainability of Qorir Small scale irrigation scheme. Some of them are presented below based on the summary of the study result:

- Poor water distribution/scheduling and failure to get sufficient water at down streams according to design, occur mostly due to the extravagant use of head-end irrigators or water scarcity due to rainfall shortage. Some farmers use water for their farm regardless of crop water requirement of each crop type.

- Weak water committee that fails to effectively manage water distribution schedule

- Water volume decrease in the reservoir is also considered as a challenge. Because of the prevalence of inadequate run off into the reservoir, farmers could not get enough irrigation water for their farm activity.

- Pertinent education and training about the use of irrigation water together with the long term consequences have great importance in smoothing the operation of the scheme under operation. However, irrigators are not sufficiently aware about the water requirement of different types of crops, and hence, frequent conflict arises among them.

- Lack of adequate external support (in water and conflict management, technical assistance and capacity building) by local development agents and the other concerned partners even though the regional institutional framework states that the management and operation of the irrigation system is a joint responsibility.

- Poor coordination of scheduling, inadequate coordination of water distribution and increasing number of water users in the command area have had contribution for the problem of water scarcity in the study area.

Generally, the main challenges that hinder the sustainability of Qorir Small Scale Scheme are inadequate runoff, poor water management practices, excessive seepage and water logging.

4.6. Irrigation Management and Irrigated Agriculture in the Irrigation Scheme

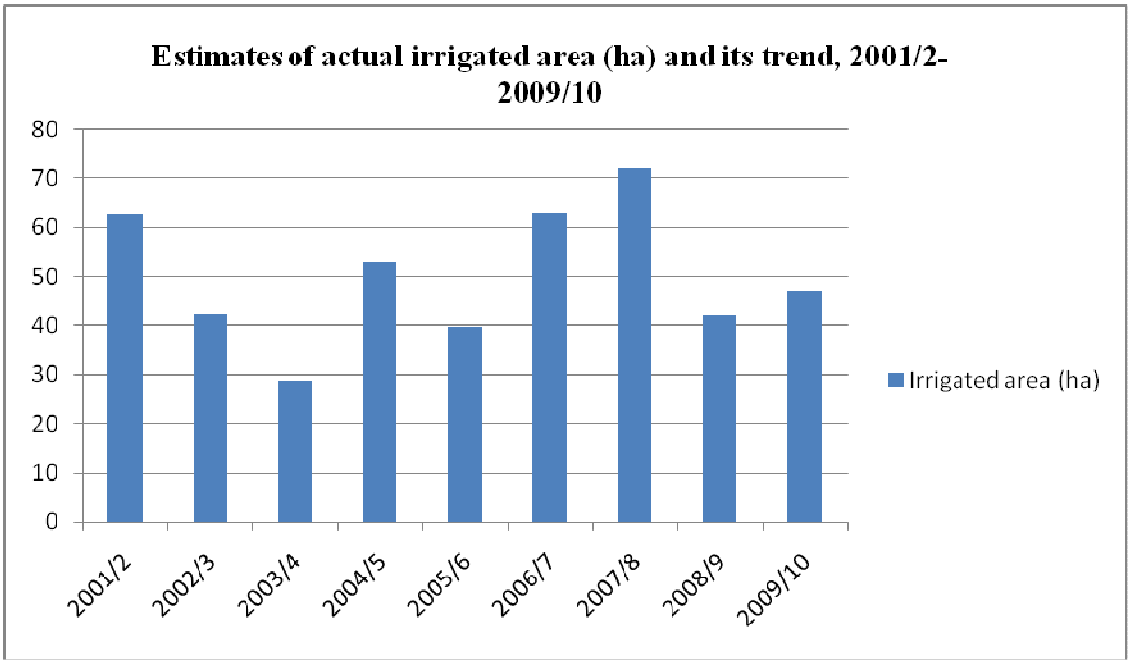
4.6.1. Irrigation Management and Utilization of the Developed Land

The farmland in Qorir small scale irrigation scheme is broadly categorized into rainfed and irrigable land. In the study area, the irrigable land is further classified into "*Gimede and Gujele*". *Gimede* is the most fertile land and close to the water source. It is the first step to cultivate and irrigate all over the year even if the volume of water in the reservoir is low. *Gujele*, on the other hand, is less fertile land and far from the water source. It is the second step to cultivate and it will

be cultivated if and only if there is enough water in the reservoir if not it will be kept uncultivated. Therefore, beneficiaries in the irrigation scheme have farmland both in the *Gimede* and *Gujele* part of the farmland.

According to the Woreda Agricultural and Rural Development Office, the plot size allocated for beneficiaries in the irrigation scheme ranges between 0.125ha (0.5tsmad[3])-0.25ha (1 tsmad), with visible substantial land fragmentation. The allocation was based on family size. Those who had large family size got up to 0.25ha. Based on the findings of the time series analysis (2001/2-2009/10), the actual irrigated area is small compared to the potential (100ha) ones.

Figure 4.1: Estimates of Actual Irrigated Area (Ha) and its Trend, 2001/2-2009/10



Source: Klite-Awlalo Woreda Agriculture and Rural Development Office (WRDO), 2011

[3] is an area of land that can be plowed by a pair of oxen in a day and is a approximately equal to quarter of a hectare

Figure 4.1 shows that the area commanded for irrigation farming for the last 8 years, which ranges from 28-72 ha of land. This clearly shows the fluctuation in the sizes of irrigated areas following the volume of annual rainfall.

Table 4.12: Farmers' Ranking of the Reasons for Underuse of Their Irrigable Land in 2002 E.C

Do you irrigate all of your irrigable land in 2002 E.C.?		Frequency	Percent	
Responses	**Yes**	55	45.8	
	No	65	54.2	
	Total	**120**	**100**	
What are the major reasons for under use of your irrigable land?		Frequency	Percent	Rank
Responses	Water scarcity	27	22.5	1st
	Shortage of oxen	12	10	3rd
	Unreliable access to water	1	0.8	5th
	Shortage of labor	18	15	2nd
	The plot I possess is large	7	5.8	4th
	Total	**65**	**54.2**	

Source: Field survey, 2011

According to table 4.12, 54.2% of beneficiaries in the irrigation scheme responded that they did not fully irrigate their farm land in 2002 E.C. The table also shows farmers ranking of the constraints that discouraged them from participation in irrigated farming and led to the underutilization of the irrigable farm land.

The result obtained in Qorir SSI mentioned also that water scarcity, shortage of labor and shortage of oxen as the 1st, 2nd and 3rd most important factors responsible for under use of the potential irrigable land respectively.

4.6.2. Irrigation Management and Crop Production

Irrigation is a key factor of success in increasing the overall agricultural productivity and crop diversification in Ethiopia. Irrigation increased crop diversification and intensification of land use practices such as double cropping.

One of the most important social effects of the implemented irrigation project was increased diversification of production. One method to show the impact of the intervention on diversification is through comparison of crops and vegetables cultivated by farmers before and after irrigation. The finding (table 4.13 and fig.4.2) indicated that the types of crops and vegetables and the number of farmers who grew a wide range of crops and vegetables, including potato, tomato, maize, onion, cabbage and pepper have substantially increased after the introduction of irrigation. The Chi-square test also revealed that the production of cabbage ($P<0.05$) and pepper ($P<0.05$) was significantly different before and after the introduction of irrigation in Qorir irrigation scheme.

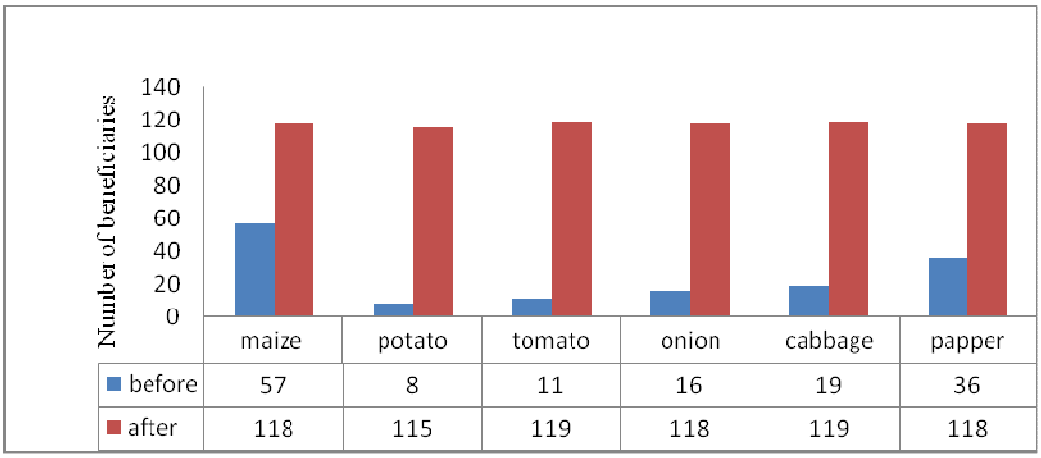
Table 4.13: Comparison of Agricultural Diversification Before and After Irrigation

Crops and vegetable	Before		After		
	Frequency	**Percent**	**Frequency**	**Percent**	**X^2-value**
Maize	57	47.5	118	98.3	2.2480
Potato	8	6.7	115	95.8	1.4907
Tomato	11	9.2	119	99.2	0.1018
Onion	16	13.3	118	98.3	2.3664
Cabbage	19	15.8	119	99.2	5.3605*
Pepper	36	30	118	98.3	4.7458*

Source: Field survey, 2011 *=Significant at 5%

The second most important impact of the implemented Qorir SSI project was increased intensification of land use practices (temporal diversification of production) in the irrigation system.

Figure 4.2: Comparison of Crop and Vegetable Diversification Before and After Irrigation



Even though the Chi-square test revealed that the production of potato, tomato, maize and onion insignificantly different before and after the introduction of irrigation in Qorir irrigation scheme, the above figure clearly shows that there is a remarkable difference before and after the introduction of irrigation scheme.

Table 4.14: Irrigation Beneficiaries' Response on the Frequency of Harvest in a Year

How many times do you produce in a year by applying irrigation?		**Frequency**	**percent**
Responses	Once	0	0.00
	Twice	83	69.2
	Thrice	37	30.8
	Total	120	100

Source: Field Survey, 2011

The researcher asked a question that 'how many times do you produce in a year by applying irrigation?' to the beneficiary farmers. According to the response, 83(69.2%) and 37 (30.8%) (See table 4.14) of farmers responded that they can produce twice and thrice in a year respectively. This clearly shows that irrigation can facilitate agricultural production intensification that means irrigation schemes helps to increase agricultural productivity of a given land in the study area. And it also helps to diversify product types.

Table 4.15: Farmers' Responses on Crop Failure and Perceptions on Possible Causes of Crop Failure

Have you ever faced a problem of crop failure while you are using irrigation?		**Frequency**	**Percent**
Responses	Yes	102	85
	No	18	15
	Total	**120**	**100**
What are the possible causes for crop failure?		**Freq. N=102**	
Causes	Water shortage	14	11.7
	Damaged by disease	85	70.8
	Poor adoption of varieties used	3	2.5
	Total	**102**	**85**

Source: Field survey, 2011

With reference to table 4.15, 85% of the beneficiary farmers responded that they were faced a problem of crop failure while they are using irrigation. The prevalence of crop and vegetable disease, water shortage and poor adoption of varieties used were the most important constraints that dictate and brought about a change in cropping pattern in the irrigation scheme. Table 4.15 shows that 70.8% of beneficiary farmers responded that they have faced crop failure due to disease. During the study time, all farmers faced tomato damage due to the prevalence of disease. The rest 11.7% and 2.5% of beneficiary farmers faced crop failure due to water shortage and poor adoption of varieties used respectively.

Table 4.16: Farmers' Response about Support Received From DAs

Do you receive support from DAs?		Frequency	Percent
Responses	Yes	89	74.2
	No	31	25.8
	Total	**120**	**100**
What are the supports you received?		**Freq. N= 89**	
Supports	Advice	65	54.2
	Training	14	11.7
	Demonstration	4	3.3
	Conflict resolution	5	4.2
	Controlling water distribution	1	0.8
	Total	**89**	**74.2**

Source: Field survey, 2011

Table 4.16 clearly shows that a greater number (74.2%) of beneficiary farmers of Qorir SSI Scheme received support from DAs. And among the services they received, advice and training take the lion's share. Supports from experts (DAs) should be a continuous process. A one-time support can not bring about a desired effect on the production and productivity of irrigation agriculture. The remaining 25.8% of beneficiaries do not get support from experts. On the beneficiaries side, farmers may not be aware about the essence of supports given by experts; they are in need of per diem because some of the trainings given at grass root level are free from per diem as a result some irrigators opt to be absent. On the experts' or development agents' side, in addition to absence of per diem payment, experts may require to pay the maintenance and fuel cost of the motor bicycles from their own pocket that will not be reimbursed. This condition may discourage them to carry out fieldwork many times that involves all beneficiaries.

Table 4.17: Farmers' Response about Credit Service for Their Agricultural Activities

Do you get an access to credit?		**Frequency**	**Percent**
Responses	Yes	96	80
	No	24	20
	Total	120	100
What are the sources of credit?			
	Cooperatives	52	43.3
Sources	Local lenders	3	2.5
	Neighbors and relatives	3	2.5
	Microfinance institutions	38	31.6
	Total	96	80

Source: Field survey, 2011

As it can be seen from table 4.17, 80% of the farmers were able to use credit for their agricultural activities. The major sources of credit for beneficiary farmers were cooperatives (43.3%) and microfinance institutions (31.6%). On the other hand, 20% of the farmers did not use credit for their agricultural activities. The reasons for their inability to use credit were, they were not interested (10.8%), requirement of collateral (4.2%), lack of access to credit supply (1.7%) and high cost of access to credit (3.3%).

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

The major findings of the study are summarized hereafter using the objectives and/or the research questions as guides.

- Today, the issue of food security is a serious concern especially in arid and semi-arid regions, which are vulnerable to climatic instability and frequent droughts. To ensure food security in the region, the Tigray Regional Government has focused on adopting and constructing various water harvesting technologies, and Qorir small scale development project is one of the different irrigation development projects in the region.

- The water committee is responsible for water allocation and distribution, coordinating maintenance activities and conflict management in the irrigation scheme with support from development agents and extension workers. Nonetheless, the water committee in the irrigation scheme is found to be inefficient in managing water distribution in terms of adequacy, timeliness and equity in the supply of water. In Qorir small scale irrigation scheme, 35% of households did not obtain the amount of water they needed, 52.5% beneficiaries witnessed that enough water is not received due to misutilization of water and the rest 12.5% of water users acknowledged that there is also inequality in water distribution between locations and between socioeconomic groups. The result indicated that access to adequate irrigation water is more unlikely if the beneficiary farmers' irrigable plot is in the tail-end area because of poor water management and water scarcity.

- In Qorir SSI Scheme, a significant number of beneficiaries (61.7%) faced a problem of water shortage for their agricultural activities. Water scarcity, poor coordination of water distribution, water theft and farm location from the water source were the most important reasons for not obtaining the required quantity of water for irrigation over the command area of the irrigation scheme. There are also technical problems that negatively affected

water distribution in the irrigation scheme. There are some hill topographic areas in the command area of the scheme that are not reached with water because of slope.

- The research result revealed that conflict over irrigation water persistently occurs among the irrigators within and between groups. The interviewed households reported that water scarcity, water theft, lack of proper control of water distribution and competition due to increasing number of water users as the responsible factors. The chi-square test also revealed that conflict over irrigation water and farm location from the water source has a significant relationship.

- Maintenance of the canals are undertaken by mass mobilization on average once in a month. Nevertheless, the irrigation beneficiaries defer major maintenance works that require input of expert skills and industrial product (e.g. cement) to the government agencies to do it for them. In the study area, better operation and maintenance of the irrigation system was observed.

- The water committee is to be formed through election by the irrigation beneficiary community members every year to manage the irrigation. Currently, the water committee has seven members (Chairperson, Vice chairperson, Secretary, Treasury, Auditor and two operators) who are responsible for the overall management of the irrigation system. The system has a by-law in the kebelle judiciary (social court) written and legalized in 1992 E.C. Accordingly, the water committee is responsible to manage the scheme and its main roles include protecting the infrastructure from being damaged (misuse or otherwise), facilitating scheduled water use by the irrigation beneficiaries and monitoring any attempt involving violation of established regulations by users such as defaulting agreed water access schedules and trying to divert water while it is not their turn. In addition to the above mentioned roles, the water committee is also responsible for resolving disputes related to water, land and maintenance based on the by-law. However, the water committee allocates water by guess because of lack of technical capacity and support from the farmers training center. These in turn resulted in a major problem in the implementation of rotational distribution of water by the committee. This self-

organization for the management of the irrigation scheme was constrained by rainfall shortage and variability affecting the irrigated agriculture, capacity limitations in irrigation agronomy and water management, disfavoring market system and related constraints, prevailing of dominant figures in the water committee, price escalation and inadequate supply of fertilizer and improved seeds and absence of a Water Users Association (WUA).

- Although the dam was meant to irrigate hundred hectares of the vast command area along the downstream, it irrigates about 50 hectares on average and that is small as compared to the potential. The study identified that water scarcity, shortage of labor and shortage of oxen were the most important factors responsible for underuse of the potential irrigable land.

- Since irrigation has positively affected farmers' livelihood through its effect on increased diversification and intensification of production, the development of well managed small scale irrigation systems that involves improved on-farm water management, organizational and other infrastructural development is required. As the study revealed, the types of crops and vegetables and the number of farmers who grew a wide range of crops and vegetables have substantially increased after the introduction of irrigation.

- However, in the study area farmers faced constraints that hinder the production diversification. Such factors include weakness in water management, prevalence of disease because farmers have not regularly been supplied with improved adaptable seeds of vegetables and crops that work under irrigation and continuous decline in the amount of water conveyed into the scheme.

5.2. Recommendations

To enhance sound irrigation management practices and to maximize the socioeconomic benefits of Qorir Small Scale Irrigation Scheme, the following recommendations and policy options are proposed:

- The water committee in the irrigation scheme is found to be inefficient in managing water distribution in terms of adequacy, timeliness and equity in the supply of water. Hence, strong institutional setup which can manage the system has to be developed or strengthening the existing one i.e. the existing water committee has to be transformed to Water Users' Association (WUA) and Periodical training and frequent follow up has to be conducted to Water Users' Association.

- In spite of lack of strong system management, water scarcity, disfavoring market system and related constraints and price escalation and inadequate supply of fertilizer and improved seeds, acceptable commitment of farmers and the impact of the implemented SSI on farmers' livelihood was observed. Hence, small scale irrigation should be promoted where it is most demanded. But farmers' priorities and interest, compatibility of irrigation with the environment and farming system of the area and opportunities of irrigation should be understood before intervention.

- Lack of regular supply and high price of inputs were one of the constraints of users for self management of scheme. The regional government, therefore, should take prompt measure to avail inputs regularly at an affordable price to the irrigators.

- The major factors for the underperformance of Qorir Small Scale irrigation scheme is water loss as a form of seepage and water scarcity. Therefore, the sustainability of the scheme should be secured by reducing the seepage water loss rate through expansion of cemented canal in the command area and beneficiaries should introduce technologies that minimize water scarcity like drip irrigation.

- There has been a continuous decline in the quantity of water conveyed in to the dam. This may lad to progressive degeneration and collapse of irrigation in the lower-catchment area. Hence, the Government and Non government actors involved in small scale irrigation development should design means of enduring the sustainability of the agricultural activities in the lower-catchment area by using motor pump that can suck water from the underground. To ensure this, the integration among all stakeholders (regional water bureau, woreda water office, kebelle development office and beneficiaries) has to be strengthened.

- In the study area, shortage of labor and oxen were the most important factors responsible for the underutilization of the potential irrigable land. Hence, beneficiaries should take loan from the near by microfinance institutions (For instance, Dedebit Microfinance) to overcome theses problems.

- Strong regulatory mechanism should be designed to overcome problems related to irrigation water to provide incentives to committed and disciplined farmers whereas disincentives to defaulters.

- The transport of water from a dam to the farms needs an efficient canal networks to tackle problems such as water logging, water scarcity and soil salinity. Hence, training should be given to farmers in techniques of water management, irrigated agriculture, and conservation of resources.

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APPENDICES

Annex A: Household questionnaire

Dear Sir/Madam;

Habtamu Worku is currently studying at Mekelle University. He is undertaking a research on irrigation management practices in Tigray: the Case of Qorir Small-Scale Irrigation Scheme, Klite-Awlalo Woreda, Eastern Zone of Tigray, for the Partial fulfillment of the Requirements for the Masters of Arts Degree in Development Studies.

Knowing the management of small scale irrigation system such as water management, conflict management and service maintenance in the irrigation scheme and how users are organized for self-management of irrigation will help us to understand how to tackle the practical problems faced by these concerns.

Because you are the one who can give a correct picture of how you experience the management of irrigation scheme, the researcher requests you to respond to the questions.

Your response will be kept strictly confidential. Only it is to be used for academics purpose.

Thank you very much for your time, cooperation and help in furthering this research endeavor.

Name of Enumerator_____

Name of Supervisor _____

Yours cordially,

Habtamu Worku

Instructions to the Enumerators

1) Make a brief introduction to each farmer before starting any question;
2) Introduce yourself by greeting a farmer in the local way, tell him/her your name, and make clear the purpose of the survey;
3) Ask each question clearly and patiently until the farmer understands your point; and
4) Please fill out the questionnaire according to the farmer's reply; don't put your opinion

Instructions to the Respondents

1) Please put your answer as a tick mark (√) in each box and fill the black spaces based on the instruction given
2) Whenever necessary, multiple answer is possible

Thank You! Habtamu worku

I. Socio-Demographic Factors

1. Age of the respondent_____ in years
2. Sex of the respondent: Male ☐ Female ☐
3. The household size_____(in Number)
4. Level of education of the household head: Grade 1-4 ☐ Grade 5-8 ☐ Grade 9-12 ☐ Tertiary ☐ Can only read and write ☐ Illiterate (can't read and write) ☐

II. Water Management, Conflict Management and Operation and System maintenance issues

- **Water Management**

5. Do you get enough water for irrigation?
   Yes ☐ No ☐
6. If your answer for question number 5 is yes, how do you distribute irrigation water among yourselves?
   On need basis ☐
   On the basis of farm size ☐
   Time limit (Scheduling) ☐
   Others, specify_____
7. Who is responsible for coordination of water distribution in the scheme?
   Development Agents (DA) ☐

Elderly community leader ☐

Water Users' committee ☐

Other, specify_____

8. If your answer for question number 5 no, what do you think are the reasons? Please rank the following in order of importance to you (from 1=most important reason, to 5= least important reason)

Water scarcity ☐

Seepage loss ☐

Poor coordination of water distribution ☐

Water theft ☐

I am lower-catchment irrigator, water does not reach ☐

9. If water scarcity is the most important reason in your rank for question number 8, which of the following are important causes for you?

Seepage loss ☐

Increasing number of users ☐

Declining level of water from the source ☐

Poor scheduling of distribution ☐

Inadequate coordination of water distribution ☐

Others, specify_____

10. Taken altogether, what do you feel about the performance of Water Users committee in the management of water distribution in the scheme?

Enough water is not received due to misutilization of water (adequacy) ☐

Water is not received when needed (timeliness) ☐

Water distribution is unfair (equity) ☐

11. If your answer for question number 10 is unfair water distribution, which socio-economic groups get more water?

Farmers with large family size ☐

Farmers with large farmland ☐

Rich farmers who grow perennials ☐

Others, specify_____

12. Which group benefits more from irrigation users?

Upper-catchment ☐

Middle-catchment ☐

Lower-catchment ☐

13. What is the major management problems related to water distribution in the irrigation system?

Sanctions not imposed against illegal water users ☐

Rotation does not accomplish equality ☐

Rotations are not strictly implemented ☐

Poor coordination of water distribution by Water Users committee ☐

Others, specify_____

- **Conflict Management**

14. Have you ever faced any conflict over irrigation water?

Yes ☐ No ☐

15. If your answer for question number 14 is yes, what are the causes for it?

Water theft ☐

Water scarcity ☐

Competition due to increasing number of water users ☐

Lack of proper control of water distribution ☐

Others, specify_____

16. Whenever these disputes/conflicts over irrigation water have occurred, how did you address them?

Through elderly mediation ☐

Court arbitration ☐

Through Water users' committee ☐

Other, specify _____

17. How do you evaluate the performance of Water Users committee in resolving conflicts in the irrigation system?

They take immediate action on cases ☐

They suspend cases ☐

Water Users committee members do not enforce internal bylaws ☐

Conflict management has been improved ☐

- **Operation and System Maintenance**

18. Overall, how do you evaluate the maintenance of the scheme?

Very good ☐ Good ☐ Acceptable ☐ Poor ☐ Very poor ☐

19. If your answer for question number 18 is poor or very poor, what do you think are the causes for the problem?

Poor coordination of maintenance activities (by Water Users committee) ☐

Poor imposition of sanction on reluctant users ☐

Absenteeism of some members on maintenance days ☐

Reluctance of some members to make labor contributions ☐

Breaching of canals by illegal water users ☐

Siltation ☐

Animals' damage ☐

Others, specify_____

20. Frequency of maintenance in a year?

Monthly ☐

Once a year ☐

Twice a year ☐

Thrice a year ☐

21. Who pay for maintenance, for guard's salary and others?

The users ☐

The community (including non-users) ☐

Government ☐

NGO ☐

Others, specify_____

III. Users' participation issues

22. Did you participate in the affairs of the scheme?

Yes ☐ No ☐

23. If your answer for question number 22 is yes, indicate the aspects of your participation:

Management being as member of Water Users ☐

Labor ☐

Maintenance of the scheme ☐

Election of WUs committee members ☐

Formulation of by-laws ☐

Others, specify_____

24. Are you a member of water users committee?

Yes ☐ No ☐

25. If your answer for question number 24 is yes, what do you contribute to the irrigation water users'?

Distributes irrigation water in an equitable and timely manner ☐

Resolves disputes between irrigation users ☐

Creation and enforcement of a unified set of water use rules ☐

Prevention of illegal withdrawals of water ☐

Better maintenance of irrigation canals, drainage and other infrastructure ☐

Implements water conservation measures such as rotational distribution ☐

Others, specify_____

26. In your opinion, who is the owner of the scheme?

The users ☐

The Community ☐

The irrigation office ☐

Department of agriculture ☐

Others, specify_____

27. How do you evaluate the soil fertility of your farmland?

Fertile ☐

Infertile ☐

28. Where is the location of your plot from the water source? (Distance in meter)

Upper-catchement ☐

Middle-catchment ☐

Lower- catchment ☐

29. How is water distributed between the location of head and tail ends carried on?

Upper-catchment gets more always ☐

Only Upper-catchment get access when there is water shortage ☐

Both Upper and lower-catchment get equal access ☐

Others, specify_____

IV. Extension and Access to credit issues

30. Do you receive support from DAs?

Yes ☐ No ☐

31. If your answer for question number 30 is yes, what are the supports you received?

Advice ☐ Conflict resolution ☐

Training ☐ Controlling water distribution ☐

Demonstration ☐ Others, specify_____

32. Did you get an access to credit for your agricultural activities?

Yes ☐ No ☐

33. If your answer to question number 32 is yes, what are the sources of credit?

Cooperatives ☐ Neighbors and relatives ☐

Local lenders ☐ Micro finance institutes ☐

The irrigation office ☐ Others, specify _____

34. If your answer for question number 32 is no, why not?

No collateral ☐ High cost of Access to credit ☐

No need ☐ Others, specify_____

No access to credit supply ☐

V. Irrigation practice issues

35. When did you start to use irrigation in this irrigation scheme (in years)? _____

36. Types of crops and vegetables cultivated:

Crops and Vegetables	Before irrigation	After irrigation
Maize		
Potato		
Tomato		
Onion		
Cabbage		
Pepper		

37. If the crops you were growing under irrigation are selected by the irrigation office (if applicable), are they suitable to you?

Yes ☐ No ☐

38. If your answer for question number 37 is no, why it is so?

Coincide with other farming activities ☐

Not adaptable ☐

Water scarcity (require frequent watering) ☐

Seeds not available ☐

Prone to Disease ☐

Others, specify: _____

39. How many times do you produce in a year by applying irrigation?

Once ☐ Twice ☐ Thrice ☐

40. Have you ever faced a problem of crop failure while you are using irrigation?

Yes ☐ No ☐

41. If your answer for question number 40 is yes, indicate the crops failed: _____

42. If your answer for question number 40 is yes, what were the possible causes for this problem of crop failure?

Water shortage ☐

Damaged by disease ☐

Poor adaptation of varieties used ☐

Poor administration of water distribution ☐

Others, specify _____

43. How many hectares of cultivated land using irrigation do you have? _____

44. Do you irrigate all of your irrigable land?

Yes ☐ No ☐

45. If your answer for question number 44 is no, area of the total potential irrigable land_____, area of uncultivated land (in 2002 E.C) out of the potential: _____ (in hectare)

46. If your answer for question number 44 is no, why? Please rank the following in order of importance to you. Number them from1=most important, to 5= least important

Water scarcity ☐

Shortage of oxen	☐
Unreliable access to water	☐
Shortage of labor	☐
The plot I possess is large	☐

Dear Sir/Madam;

Habtamu Worku is currently studying at Mekelle University. He is undertaking a research on irrigation management practices in Ethiopia: the Case of Qorir Small-Scale Irrigation Scheme, Klite-Awlalo Woreda, Eastern Zone of Tigray, for the Partial fulfillment of the Requirements for the Masters of Arts Degree in Development Studies.

Annex B: Checklist for key Informant Interview

- ✓ Major crops grown before and after using irrigation water?
- ✓ What were the trends of food security in the past three years?
- ✓ Major institutional and managerial problems in the irrigation systems
- ✓ Performance of the irrigation scheme
- ✓ Historical background of the irrigation scheme

Annex C: Checklist for Group Discussion with irrigators

- ✓ Major problems in water management or principal areas of users' complaints.
- ✓ Organization, management performance and weaknesses of WUs-committee
- ✓ Water management in the irrigation system: Water allocation, distribution and maintenance issues
- ✓ Bylaws and enforcement characteristics
- ✓ Conflict and conflict management in the irrigation scheme
- ✓ Supports given from the local Irrigation Office and local governance
- ✓ Farmers' perception about benefits of irrigation and its sustainability
- ✓ Support services; Credit, input(seed) and extension
- ✓ The major constraints of irrigation farming in the irrigation scheme

Annex D: Checklist for Interview to Water Users' Committee

- ✓ Bylaws and their enforcement
- ✓ Conflict and conflict management

- ✓ Major problems in relation to water management, conflict management and canal maintenance
- ✓ How did you organized for self-management of the irrigation scheme
- ✓ The major challenges that hinder the sustainability of the scheme
- ✓ The contribution of the water user committee

Annex E: Chi-square test results of crops and vegetables before and after the introduction of irrigation

Table 1: tab beforeirrmaize afterirrmaize, chi2

before irrigation maize	after irrigation maize yes	no	Total
yes	55	2	57
no	63	0	63
Total	118	2	120

Pearson chi2(1) = 2.2480 Pr = 0.134

Table 2: tab beforeirrpotato afterirrpotato,chi2

before irrigation potato	after irrigation potato yes	no	Total
yes	7	1	8
no	108	4	112
Total	115	5	120

Pearson chi2(1) = 1.4907 Pr = 0.222

Table 3: tab beforeirrtomato afterirrtomato,chi2

before irrigation tomato	after irrigation tomato yes	no	Total
yes	11	0	11
no	108	1	109
Total	119	1	120

Pearson chi2(1) = 0.1018 Pr = 0.750

Table 4: tab beforeirronion afterirronion,chi2

before irrigation onion	aftre irrigation onion yes	no	Total
yes	15	1	16
no	103	1	104
Total	118	2	120

Pearson chi2(1) = 2.3664 Pr = 0.124

Table 5: tab beforeirrcabbage afterirrcabbage,chi2

before irrigation cabbage	after irrigation cabbage yes	no	Total
yes	18	1	19
no	101	0	101
Total	119	1	120

Pearson chi2(1) = 5.3605 Pr = 0.021

Table 6: tab beforeirrpepper afterirrpepper,chi2

before irrigation pepper	after irrigation pepper yes	no	Total
yes	34	2	36
no	84	0	84
Total	118	2	120

Pearson chi2(1) = 4.7458 Pr = 0.029

Annex F: Chi-square test result of the relationship between conflict over irrigation water and farm location from the water source

Table 7: tab anyconflictfaced locationofplot, chi2

have you ever faced any conflict over irrigation water	where is the location of your plot from the water source head-end	middle-en	tail-end	Total
yes	15	23	34	72
no	35	11	2	48
Total	50	34	36	120

Pearson chi2(2) = 37.3747 Pr = 0.000